EXHIBIT A

Invention Disclosure Submission Reply

Disc No:	13527RO	Received Date:	
Disclosure Title:	Domain-constrained optical route flooding system for optical UNI and optical VPN services		

Inventors

Global Id	Name	Work Info	Home Info
1664443	**HR Name:** WANG, GUO QIANG **Known As:** GUOLI **Email:** guoqiang@americasm01.nt.com **Mgr First Name:** STAN **Mgr Last Name:** XAVIER **Mgr Global ID:** 1525095	**Location:** 21 RICHARDSON SIDE ROAD **Location Code:** KAN **Dept:** 0V10 **Phone:** 3954195 **Ext Phone:** 765-8020 **Fax:** **Ext Fax:** **MailStop:** 117D1A05 **Citizenship:** CANADA	**Address:** 175 LONGSHIRE CIRCLE NEPEAN, ON CANADA K2J4L2 **Phone:** (613)8255586
GPS2945913	**HR Name:** WANG, GUOQIANG G.Q **Known As:** GUOQIANG **Email:** **Mgr First Name:** **Mgr Last Name:** **Mgr Global ID:**	**Location:** 21 RICHARDSON SIDE ROAD **Location Code:** KAN **Dept:** 0V13 **Phone:** 39-54195 **Ext Phone:** 765-4195 **Fax:** **Ext Fax:** **MailStop:** **Citizenship:** CANADA	**Address:** 175, Longshire Circle Nepean, ON CANADA K2J 4L2 **Phone:** ()

Attachments

<End of Attachments>

Were there additional inventors involved?	yes	Was there contractor involvement?	no
Name of Supervisor or Divisional Head:		Name of VP:	
STAN XAVIER		STEVE LACHOWSKI	
LOB:	CORP	Business Unit:	OTHER (CORP)
Conception Date:			
Has this invention been discussed with others? If so, please complete:			
Inside Nortel - Whom?		Outside Nortel - Whom?	
Inside Nortel - When?		Outside Nortel - When?	
NDA?	yes		

Are you aware of any imminent future disclosures? Please provide dates and details

Keywords for Searching	Products that will use this invention

Does this invention [illegible] no

Is this invention relevant to Standards Activity?	[illegible] Project [illegible]
no	29153

Technical Information

Brief description of the invention

Optical network is designed to provide end-to-end light paths between user CPEs. With wavelength routing, Wavelength signaling and network resource partitioning capability, the future optical network will provideOptical VPN (Virtual Private Network) services for customers. The optical connectivity services are provided though Optical UNI (User Network Interface). Over Optical UNI, a set of functions is defined to support end-to-end light path services. These functions include to set up (tear down) the paths, to change the bandwidth dynamically against an existing path, to inquire user group information, and to get some optical layer topological information. To achieve about objective, IETF and OIF have defined some initial proposals for Optical routing, Optical signaling and Optical UNI. Three optical interworking service models have been proposed in IETF and OIF: Overlay model, Peer-to-peer model and Augment model. In Overlay model, the optical domain is separated from the other service layer domain such as IP routing domain. In this model, IP layer is a client layer of Optical layer while Optical layer is a server layer to provide light path services for IP through Optical UNI. The peer-to-peer model treats IP and optical evenly. In this model, IP routers treat optical switches as another type of "router", thus IP layer and Optical layer can exchange routing information seamlessly. The third model is an integrated model (Augmented model). In this model, the IP layer act as peers of the optical layer network, such that s single routing protocol instance runs over both IP and optical domain. Unlike peer-to-peer model in where the routing domain is a "flat" space, the Augmented model restricts the routing information of optical domain only at the boundary between IP and optical switch. In the other word, only the optical-attached router will exchange the routing information with Optical switch, not further. Which model is better for IP/Optical interworking is still a debatable topic in IETF, OIF and ITU. The fundamental issue here is how to partitioning overall network resources and who is supposed to manage what portion of these resources.This disclosure has defined a unified mechanism which can support all the three service models at the same time. We have introduced "Optical Link User Group Identification (OLUGI)" for each optical link to partitioning routing domain for various optical user groups. Coordinated with wavelength routing protocol, this OUGI is used to restrict the optical route flooding into optical network user domain based on pre-assigned flooding policy. This mechanism not only provides optical service providers a great flexibility to support various optical service model and traffic engineering, but also sets up a basis for optical VPN services in which the customer could buy a portion of optical bandwidth and manage this resource themselves.

Problem Solved by the Invention

IETF and OIF have defined three optical service models for IP/Optical interwprking: Overlay model, Peer-to-peer model and Augmented model. Each model has its own advantage and applies to a specific service scenario. This invention defines Optical Link User Group for each model, and defines the optical route flooding policy for each user group. This flooding policy restricts the route-flooding domain for each optical user group. Wavelength routing protocol is extended to propagate this information to various user groups. This method provides a policy-based routing such that the optical layer only floods route information to a "trustable domain". This "trustable domain" is defined by Service Level Agreement between optical service provide and customers. The optical network user can use this method to discover the users in the same group, and to check the status of the peer user. This method could also support Optical VPN services, in which case the customer can buy and manage a portion of optical bandwidth, through a distributed manner.

Solutions that have been tried and why they didn't work

While IETF and OIF are still debating which service model is better for IP/Optical interworking, we see that a consolidate model to support all three models will be most beneficiary for both optical service provider and optical network users. For example, the service provider MCI can support overlay model to un-trustable users by providing end-to-end light path services. At the same time, MCI optical transport group can support Peer-to-Peer model or Augmented model for MCI-UUNet group. When UUNet group hooks up their Terabit routers to optical core, by learning optical layer topology, the IP domain can conduct traffic engineering by dynamically allocate/release optical bandwidth, and even conduct IP layer protection more efficiently and reliably. This invention is the first proposal to support such consolidate optical service model.

Specific elements of steps that solve the problem and how they do it

The Service Model information, User Status information and Optical Link User Group Indentation information will be defined for Wavelength routing protocol as follows: Service model TLV: This TLV is a 32-bit integer component, the value is 0 ~ 30: default model, no service1: Overlay model. In this model, no optical route information is flooded into user domain2: Augmented model. In this model, part of optical route information is allowed to flood into user domain 3: Peer-to-peer model. In this model, all optical route information will be flooded into user domainUser Status TLV: This TLV is a 32-bit integer component, the value is 0~3.0: Out of service - This user cannot be connected1: Idle - This user is ready to accept connection request2: Busy - This user cannot receive any more connection3: Testing - This user is being tested. Cannot accept any connection at this momentOptical Link User Group Identification TLV: This TLV is defined in OSPF resource LSA as Administrative group. We define some new semantic for this TLV. It is a 32-bit integer.255.255.255.255: Broadcast group. Any optical topology information would be flooded over this link0.0.0.0: Default for disabled group. No optical LSA allowed over this linkOther: Same as OSPF administrative group. It is defined for specific user group. Optical route flooding restriction for various user group: When an optical switch receives an Optical Link State Advertisement (OLSA), it will check the link typefor each link to decide if this OLSA should be flooded over that link:Link Type

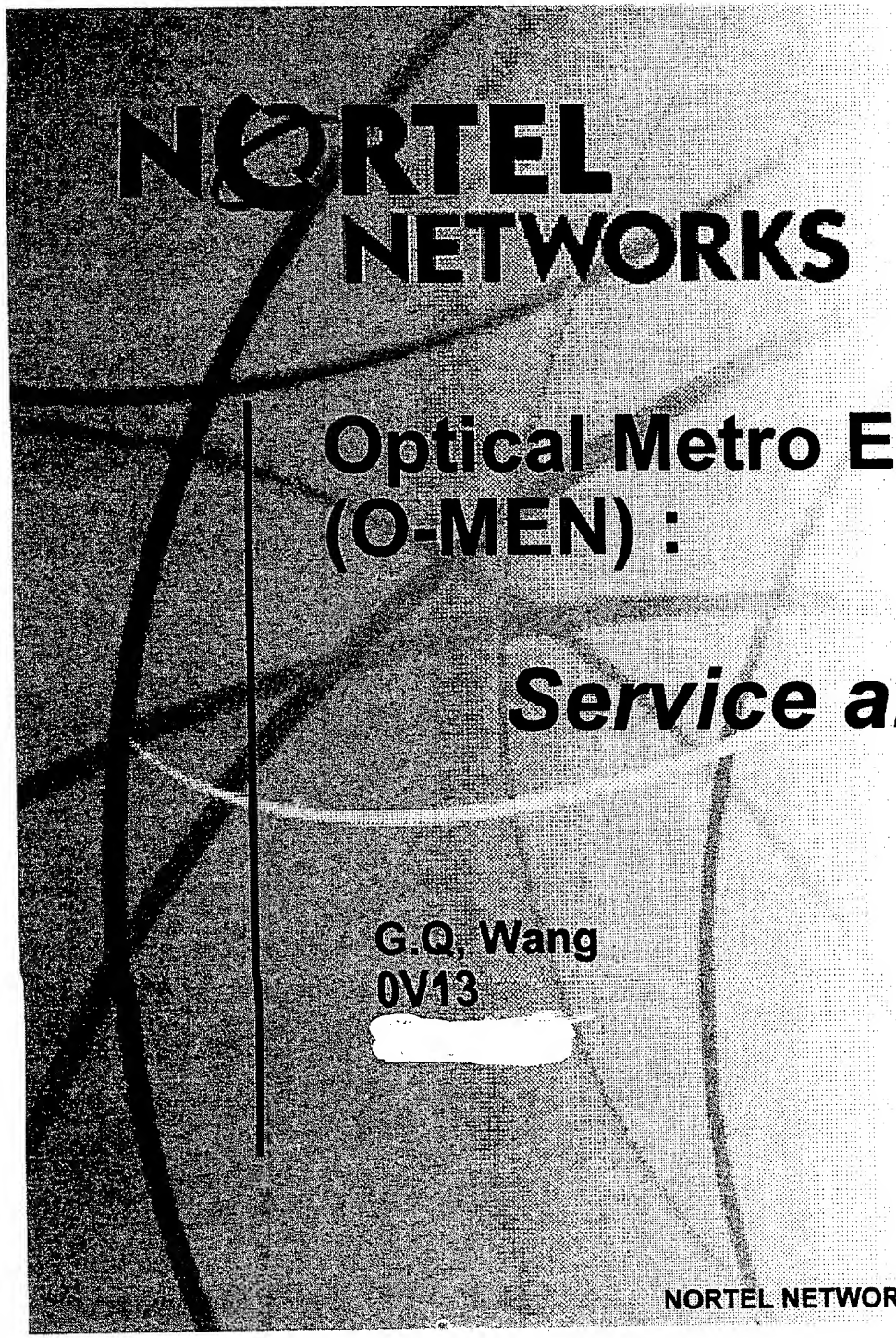
Flooding restriction255.255.255.255 Flood LSA over this link0.0.0.0 Block LSA over this linkOther value

Flood LSA only if the administrative group value is

matched. For traditional OSPF LSA, based on link ID of LSA, the optical switch will compare the link type of LSA and the link type of all out-going link, then decide over which link this LSA should be flooded.

Commercial value of the invention to Nortel and Nortel's customers

This invention will provide Nortel an approach to support various service models for IP/Optical interworking. Based on the domain-constrained flooding policy, this method provides a unified optical route flooding mechanism for Optical UNI service, it also provide an effective approach for Optical VPN services. Potentially, this approach could be merged into the on-going standard activityfor IP/Optical interworking in IETF and OIF.

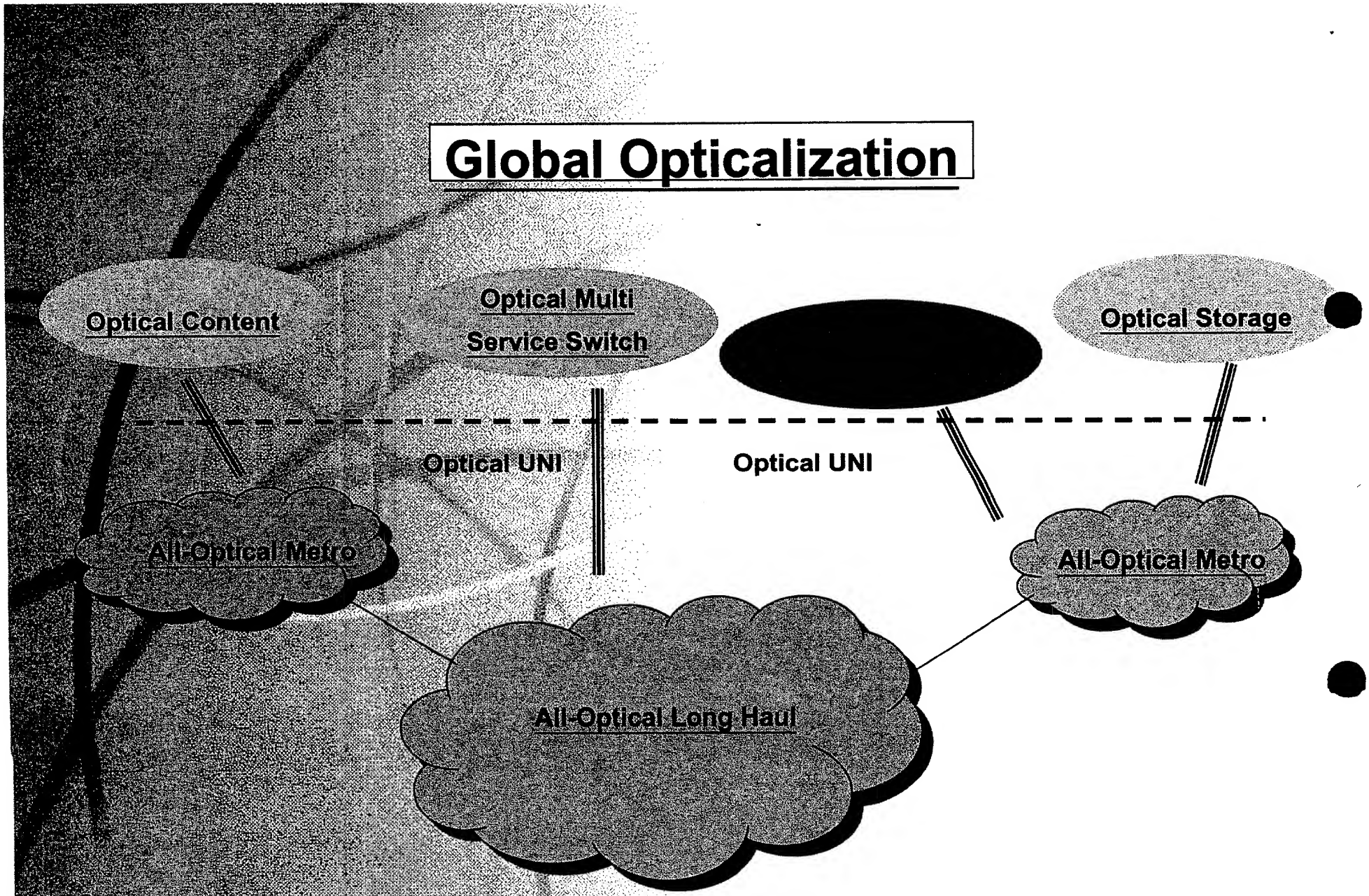


Optical Metro Ethernet Network (O-MEN) :

Service and Control

G.Q, Wang
0V13

Global Opticalization



Optical user, services and service modes

Optical User

- Trusted User
- UN-trusted user

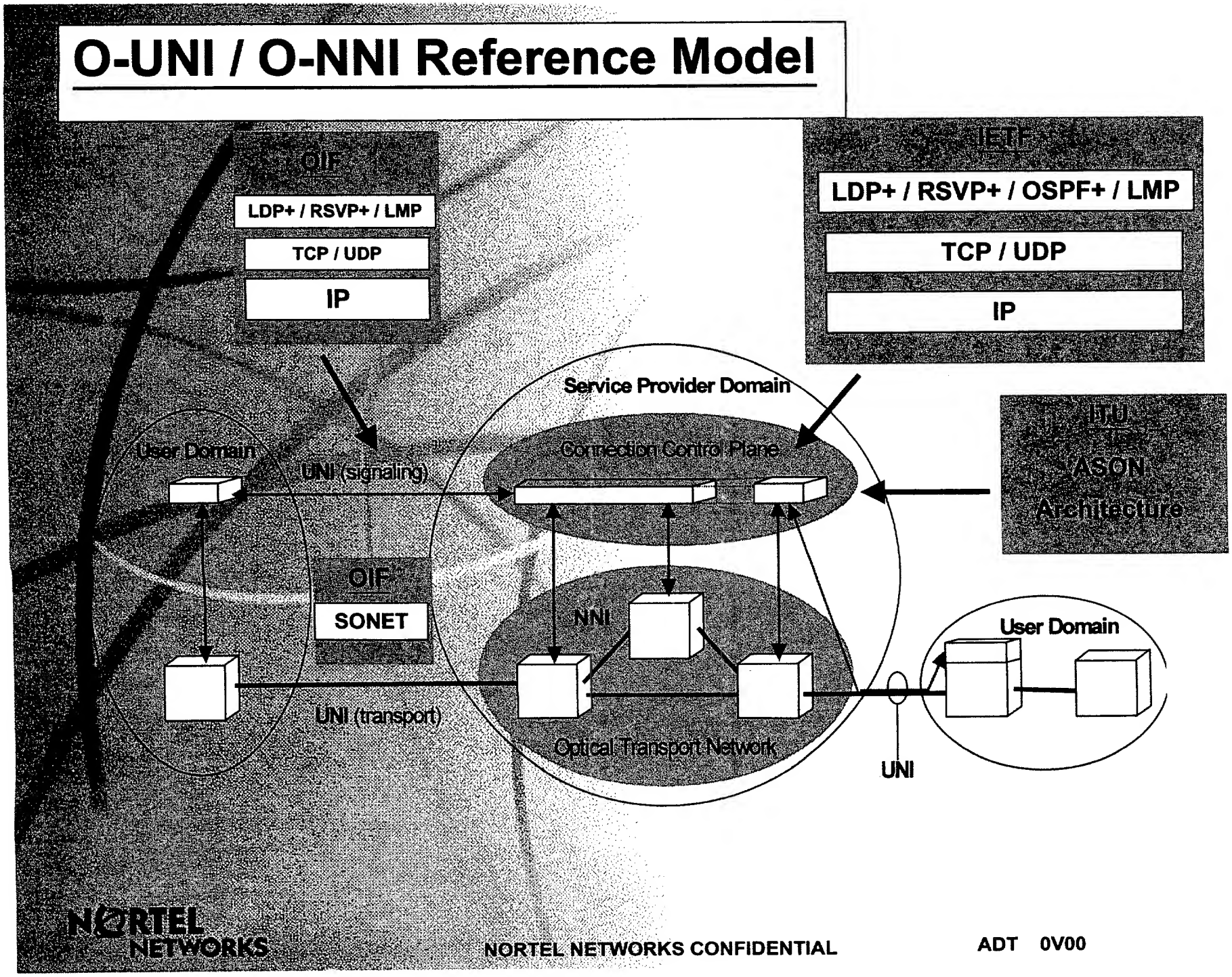
Optical service

- O-UNI management
- Optical dial tone and protection
- End-system discovery and service discovery
- Third party signaling
- Leased line
- Optical VPN
- Bandwidth trading

Optical service mode

- Overlay
- Peer-to-peer
- Augmented

O-UNI / O-NNI Reference Model



Standard: OIF, IETF and ITU

OIF

- "O-UNI 1.0 Proposal" -- OIF2000.125.2
- "Carrier Optical Services Framework and Associated Requirement for O-UNI" -- OIF2000.155.1
- "LDP Extension for UNI 1.0" -- OIF2000.140.1

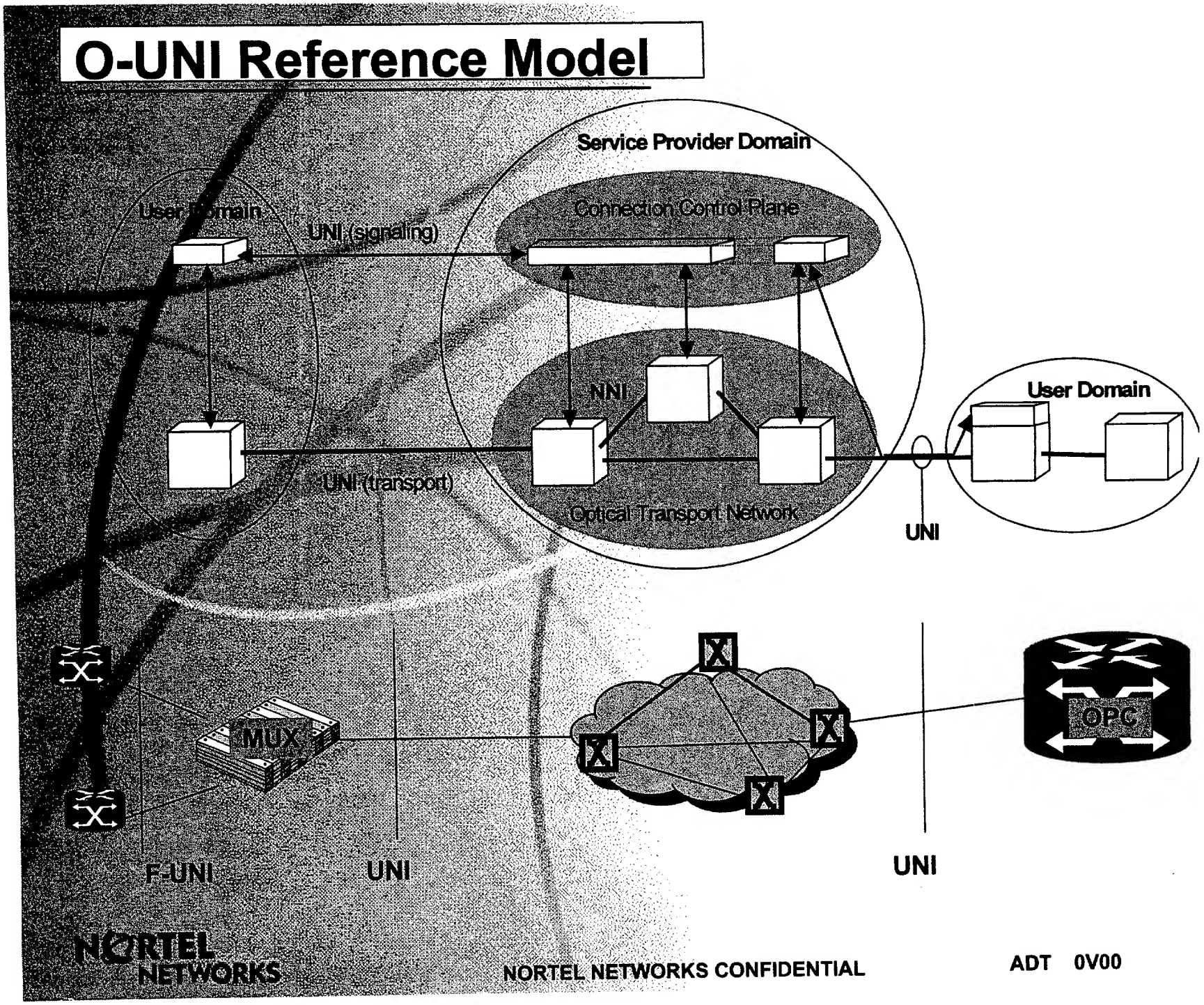
IETF

- "Generalized MPLS -- Signaling Functional Description" -- draft-ietf-mpls-generalized-signaling-00.txt
- "Extension to OSPF/IS-IS for Optical Routing" -- draft-ietf-lambda-te-routing-00.txt
- "Link Management Protocol" -- draft-lang-mpls-lmp-00.txt

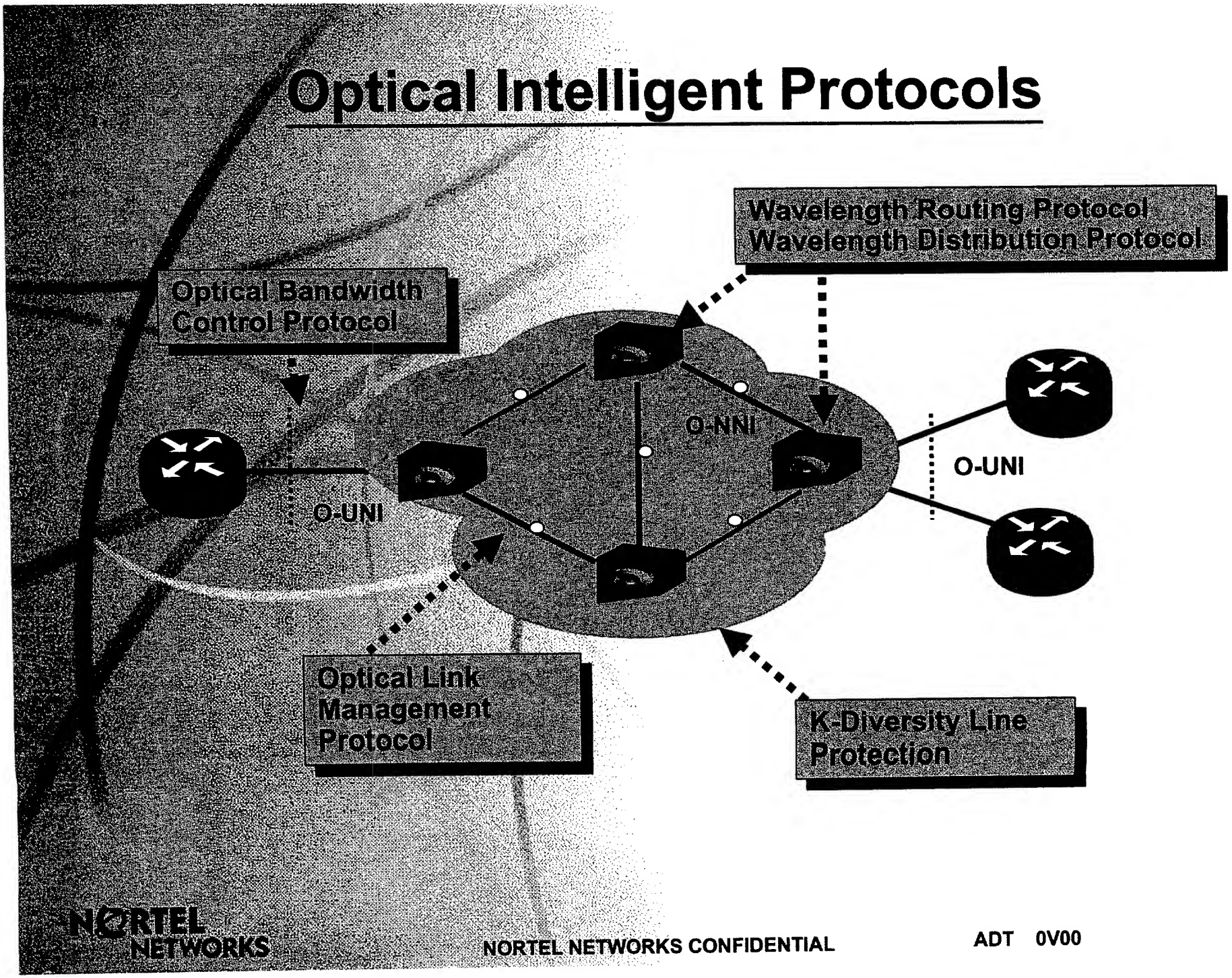
ITU

- "Network Node Interface for the Optical Transport Network -- ITU-T Draft New Recommendation G.709
- "Architecture of Optical Transport Networks", ITU Recommendation G.872
- "Architecture for Automatic Swiched Optical Network (ASON)" -- ITU Rec, G.ason,

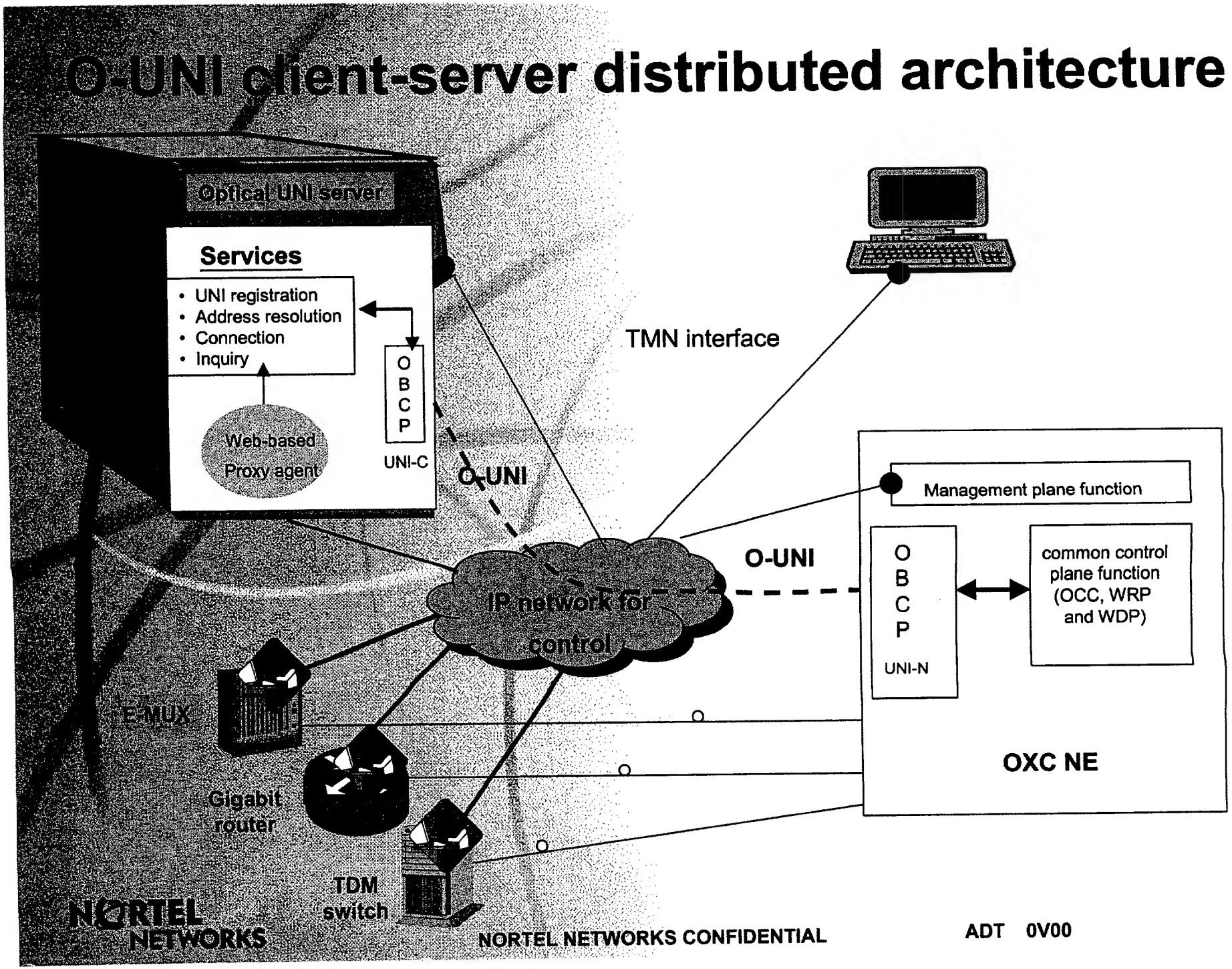
O-UNI Reference Model



Optical Intelligent Protocols

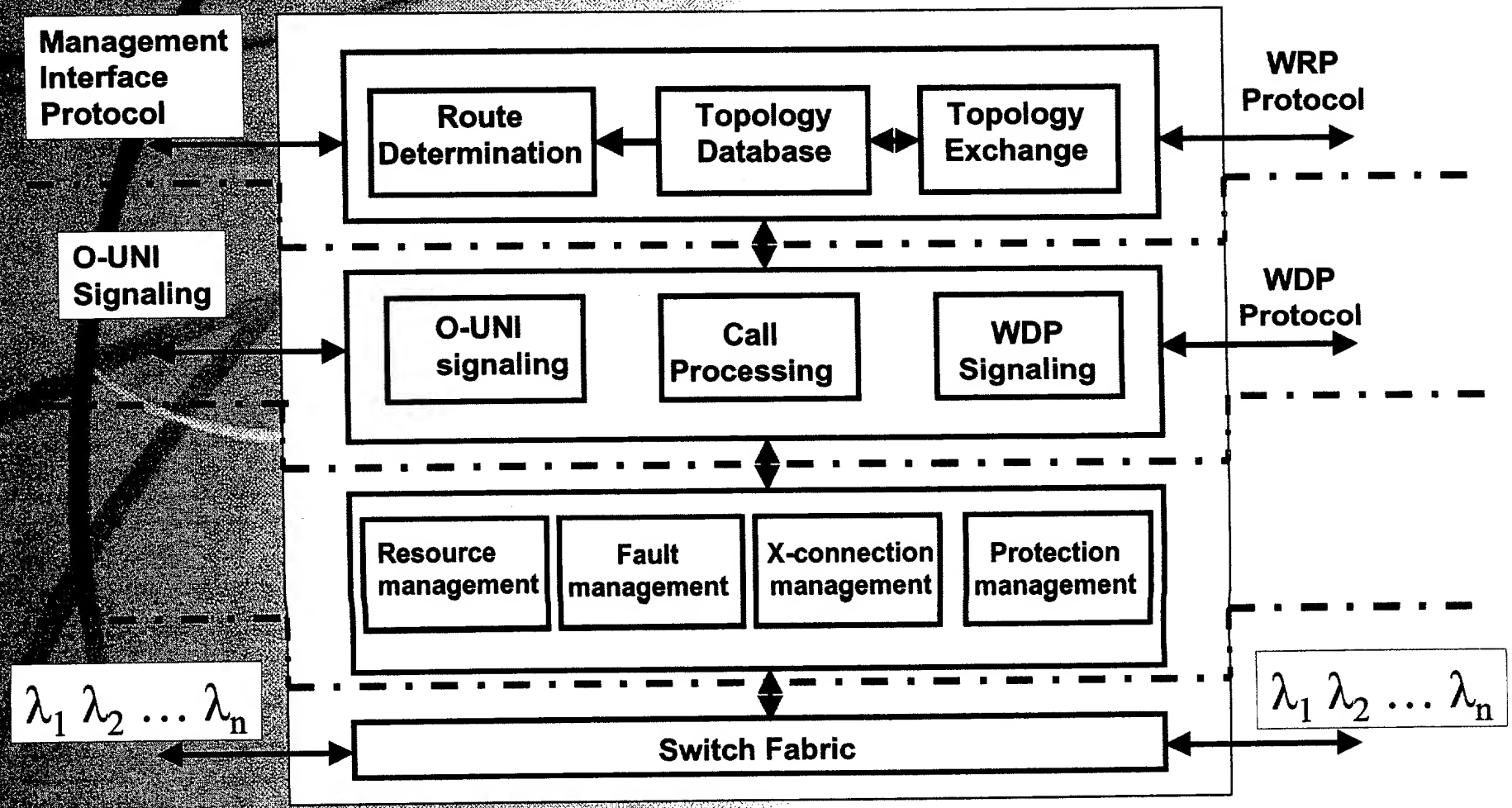


O-UNI client-server distributed architecture

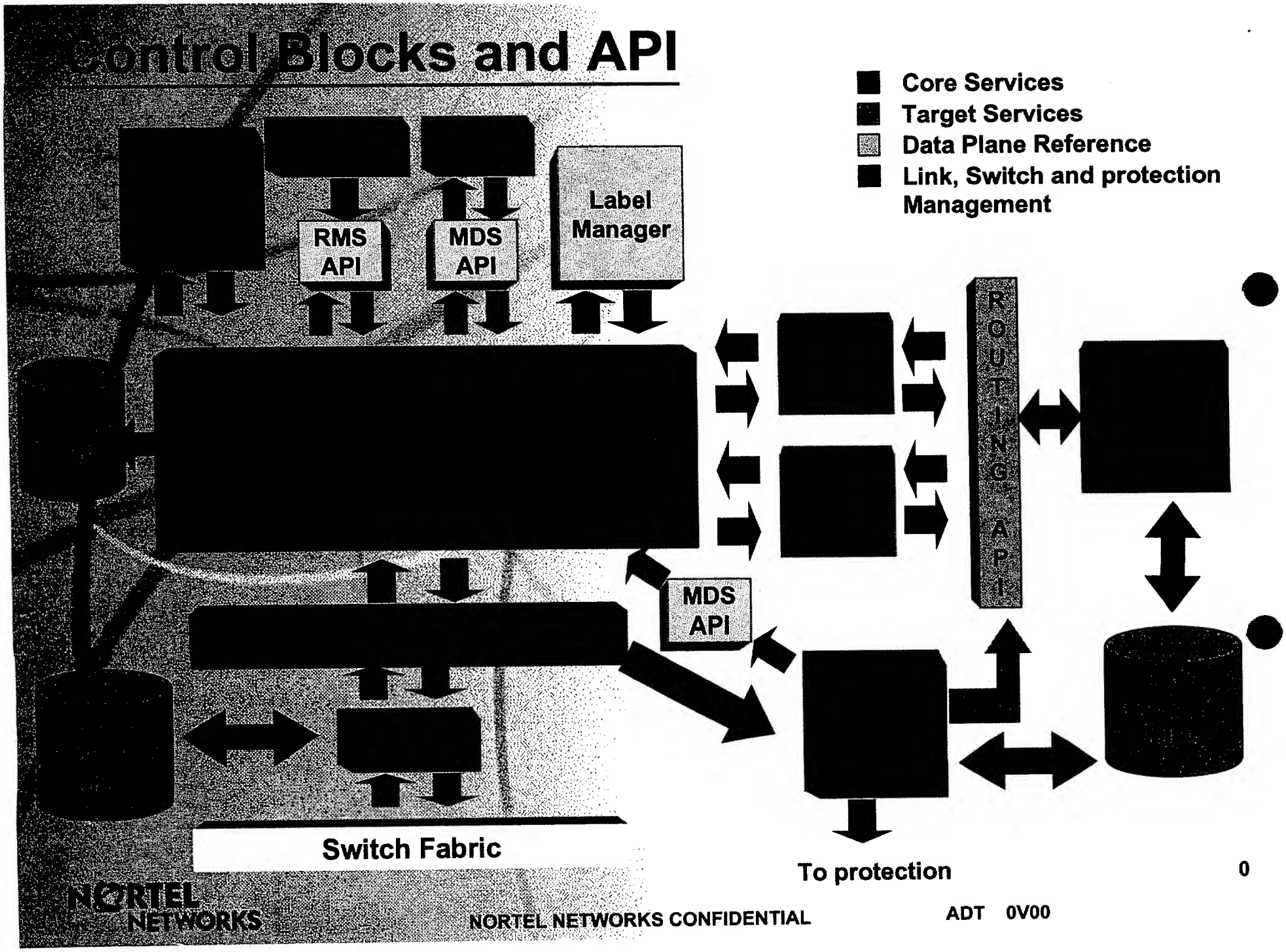


WRP & WDP

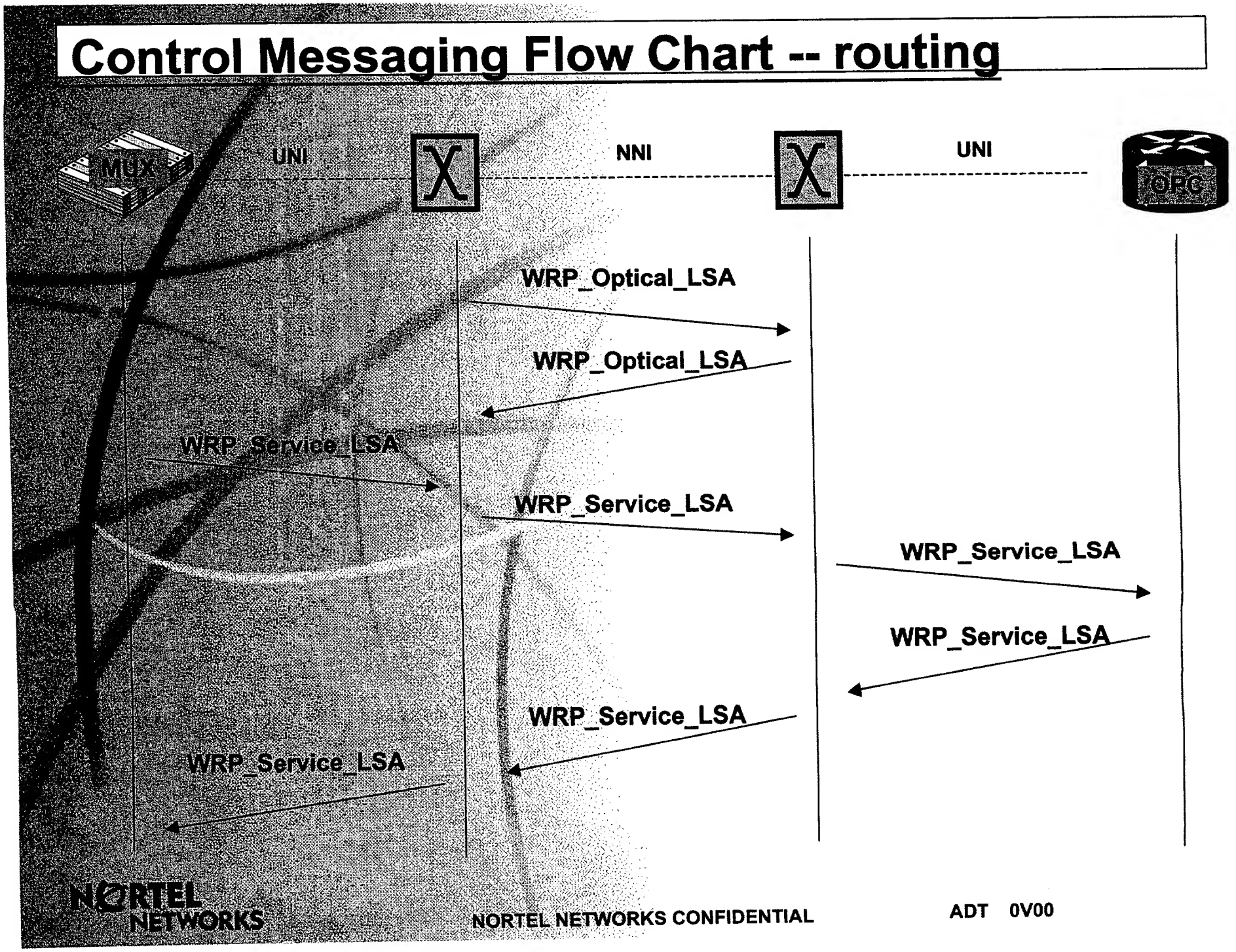
System Control Architecture Reference Model for an Optical Switch



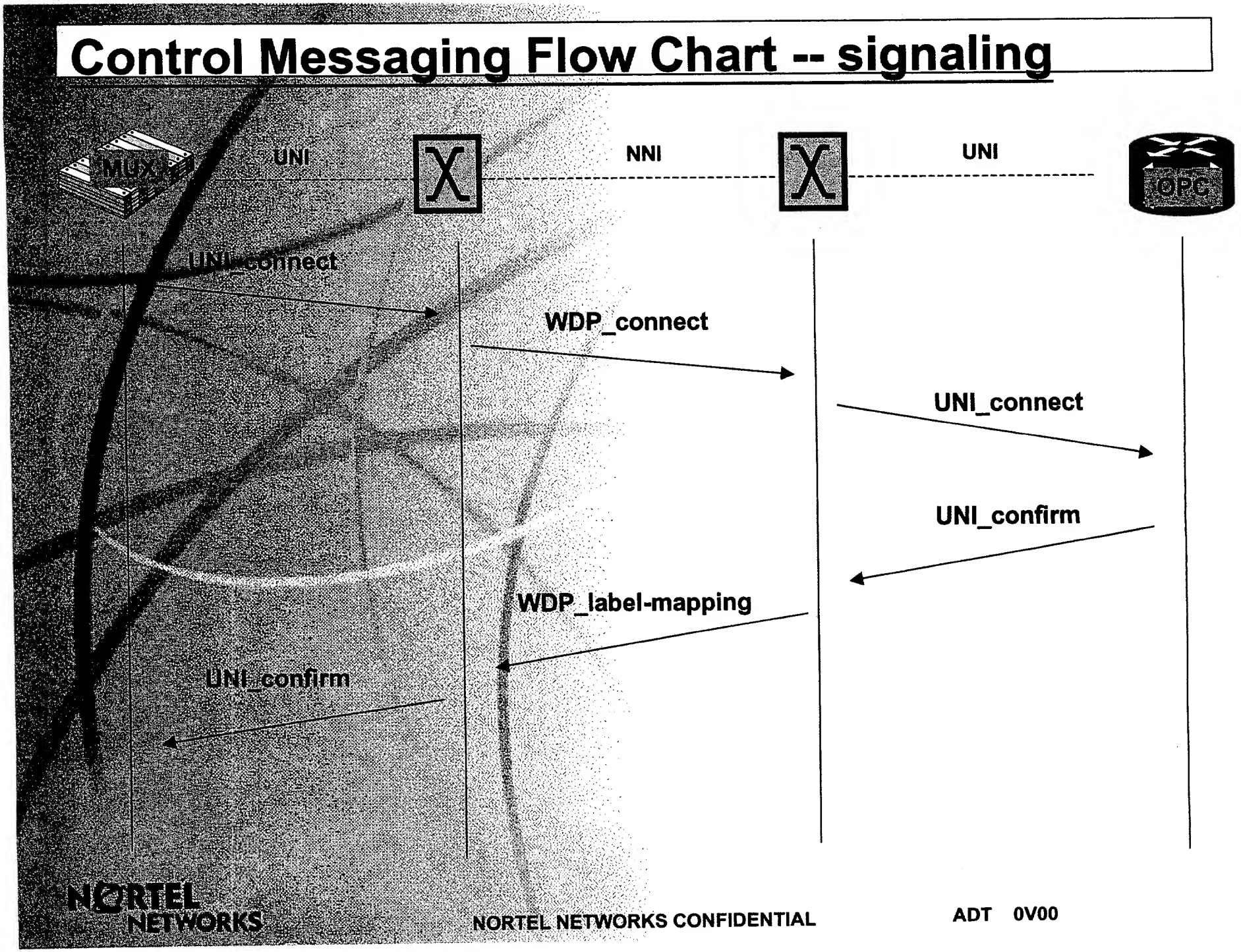
Control Blocks and API



Control Messaging Flow Chart -- routing



Control Messaging Flow Chart -- signaling



WRP & WDP

WRP Requirement

- **WRP**
  - Optical topology discovery and inventory of physical resource
  - Available/reserved resource advertisement
  - Optical bandwidth grouping at various channel granularity
  - O-UNI interworking & control integration
  - Channel/link prioritization advertisement
  - New path selection/optimization algorithm to support traffic engineering and constrain-based routing
  - All interfaces (ports) are IP-addressable
  - Integrated protection/restoration

WRP & WDP

WDP Requirement

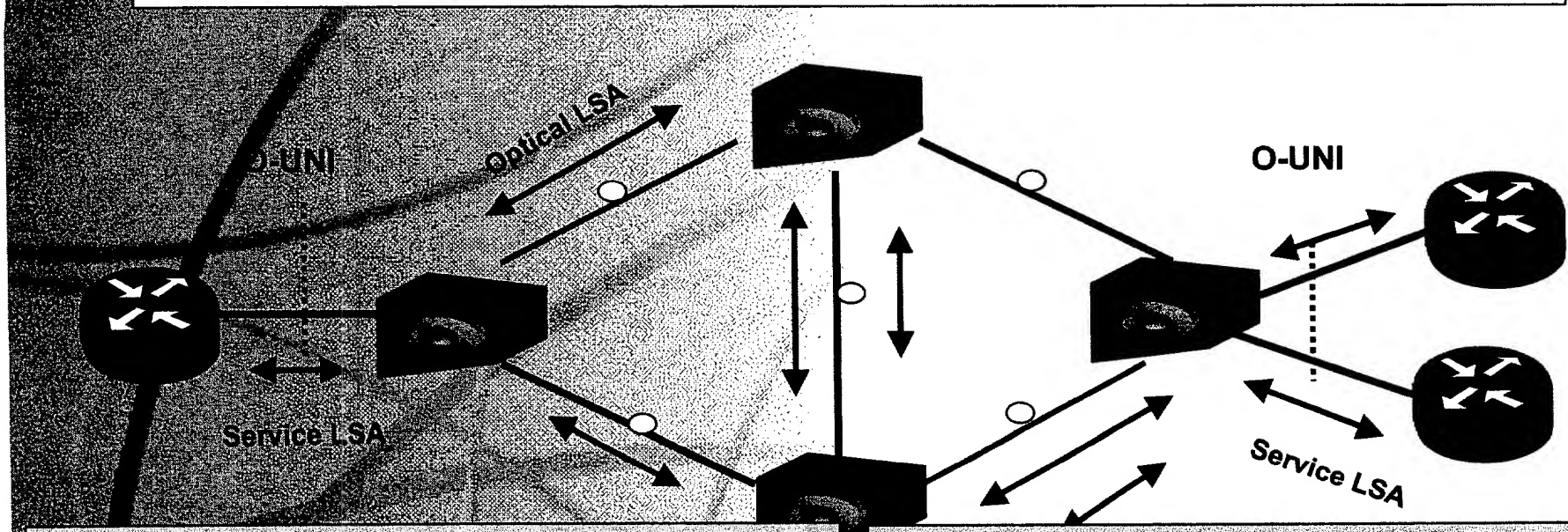
- **WDP**
  - Classified label for connection type and bandwidth
  - End-to-end signaling to setup, tear-down and modify optical paths
  - Optical traffic/interface compatibility check
  - Bandwidth assignment for optical switches with/without wavelength conversion, at various granularities with any combination
  - Path priority assignment for protection and traffic engineering

Optical Bandwidth Control Protocol

OBCP Requirement

- **OBCP**
  - O-UNI registration/de-registration
  - Connection request/release/bandwidth change
  - Service status inquiry
  - Service singling and protection
  - Neighbor discovery and service discovery
  - Optical augment routing
  - Third-party signaling and scheduling services
  - O-VPN services
  - Service policy enforcement
  - Service billing

Optical LSA and Service LSA Propagation



WRP& WDP

1. NNI is configured for each optical link
2. WRP floods Optical LSA and exchange topology for routing database
7. WDP consults from WRP to get a constraint-based path
8. WDP issues connection request with the check of the optical UNI interface type user group ID, and available bandwidth.
9. The request is confirmed or rejected.

O-UNI & OBCP

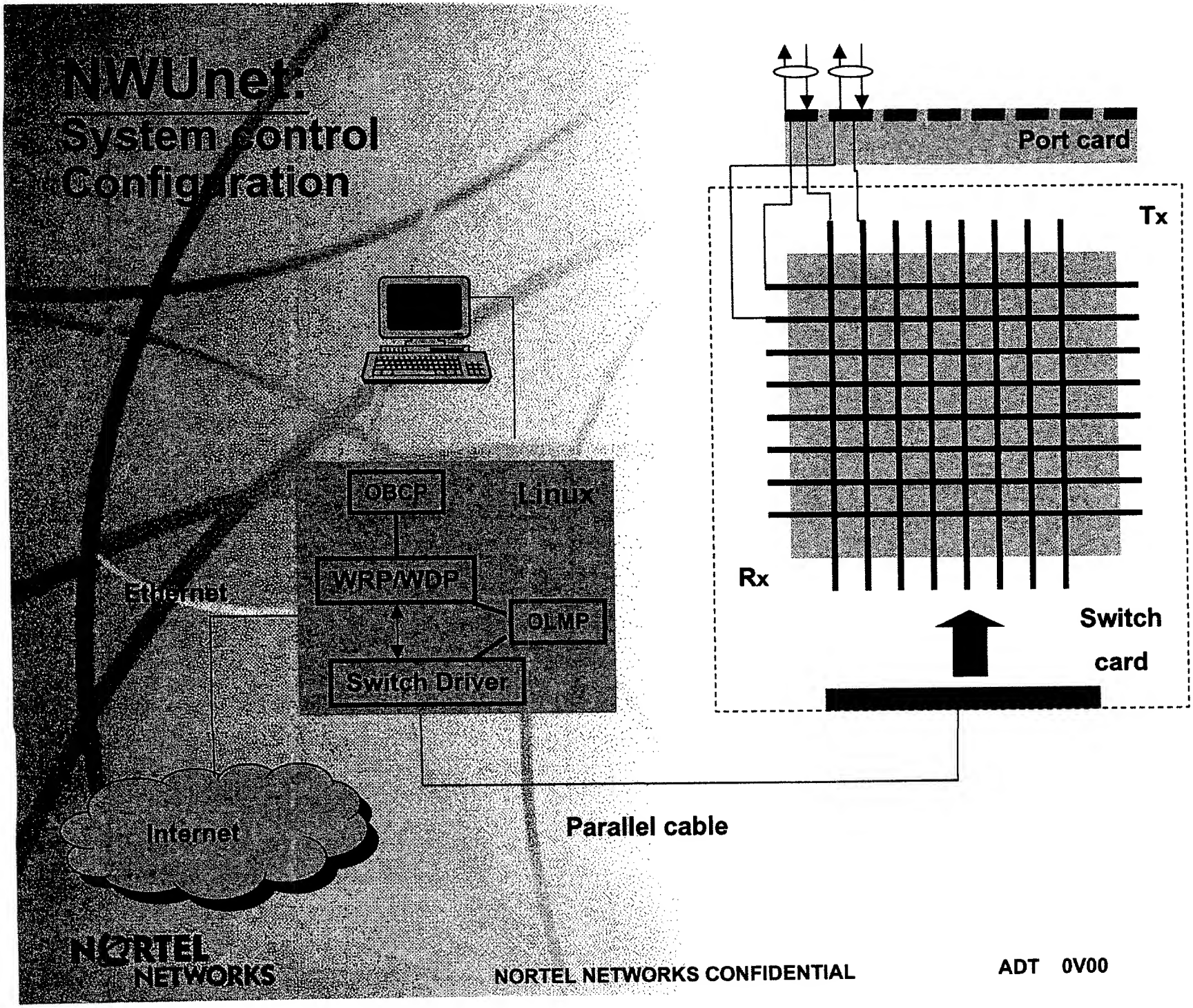
3. O-UNI is configured for each service access link
4. OBCP floods Service LSA
5. Optical switches check flooding domain to decide broadcast or block the propagation to other OBCP server
6. OBCP accepts service request from O-UNI proxy, conduct address resolution and forward the request to WDP
10. The request is confirmed or rejected.

Optical Link Management Protocol

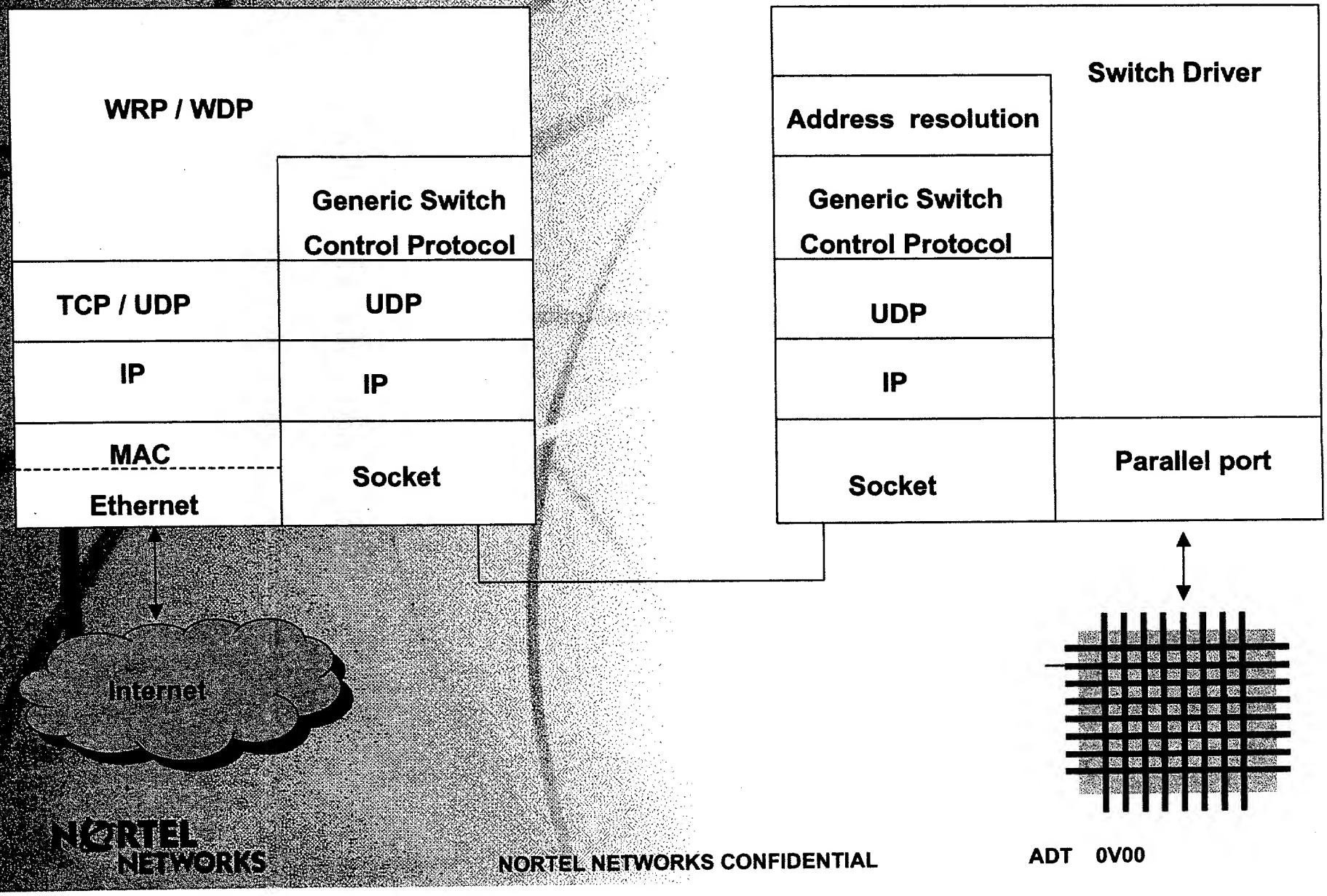
OLMP Requirement

- **OLMP**
  - Neighbor discovery
  - Link type, wavelength scope identification and negotiation
  - Bundling link
  - Control channel management and protection
  - Component link verification
  - Fault detection and fault isolation

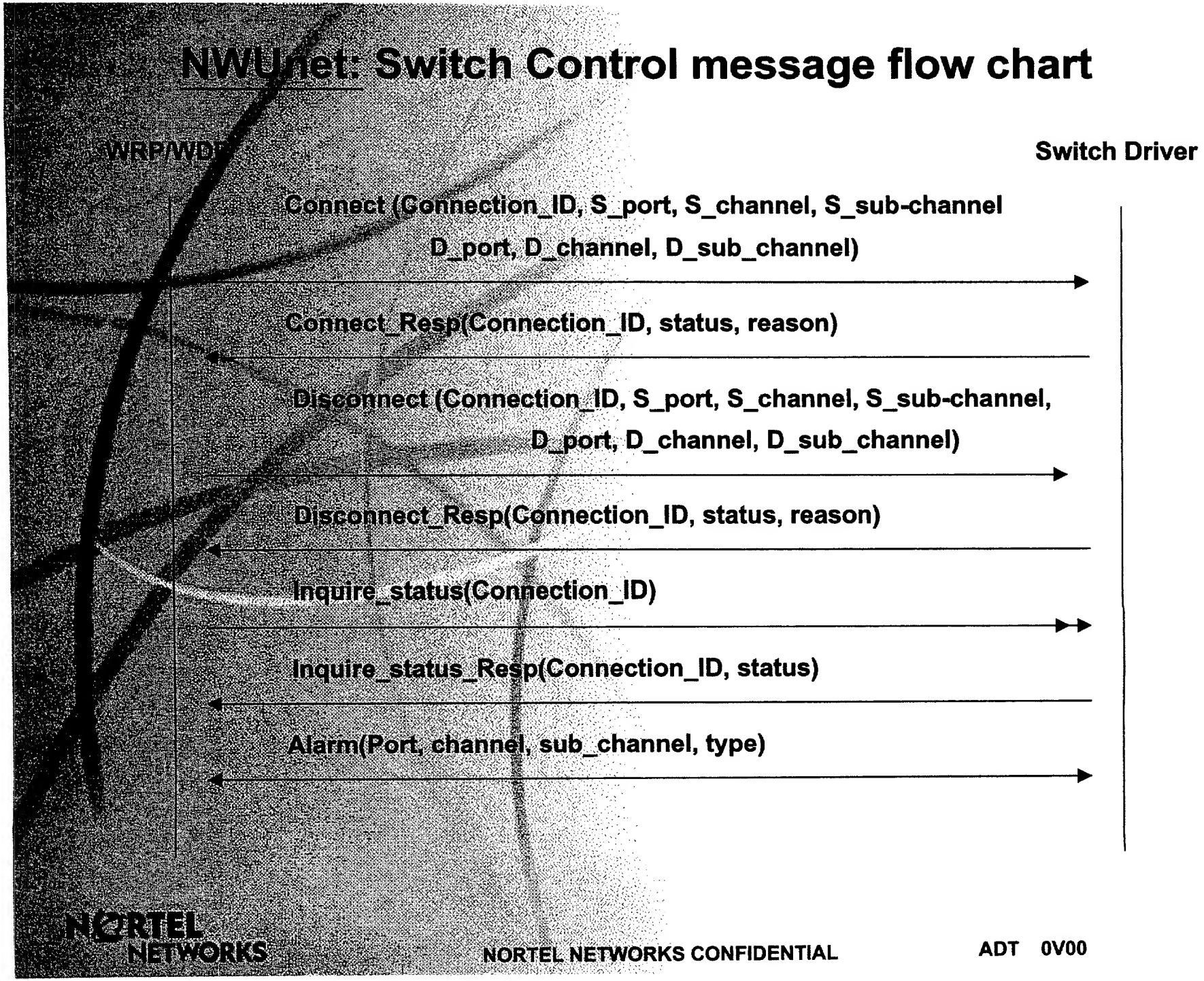
NWUnet:
System control Configuration



NWUnet: Communication Stack



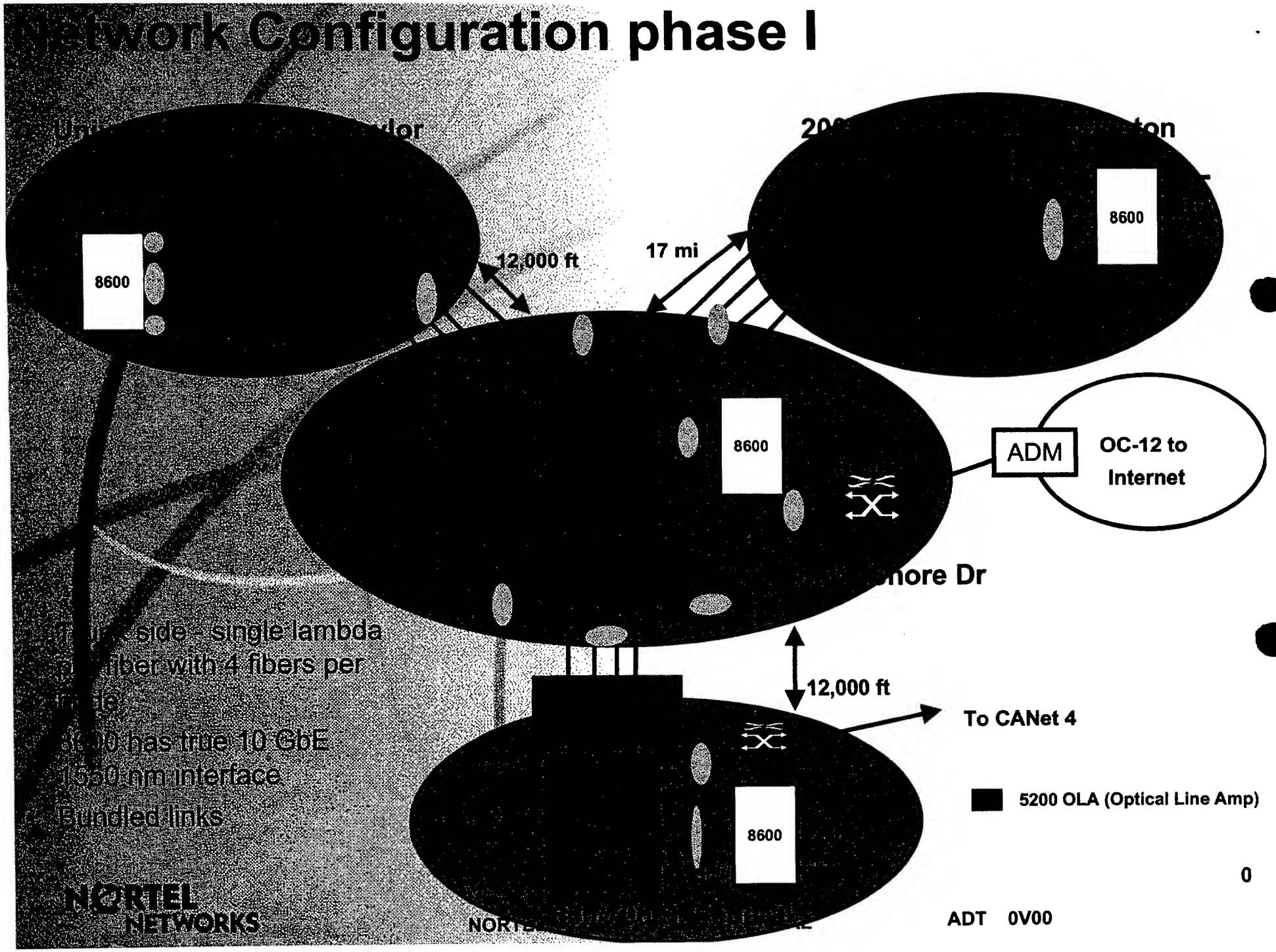
NWUnet: Switch Control message flow chart



Summary

- Services
  - O-UNI signaling & routing
  - Optical Dial tone & protection
  - Service automatic discovery
  - O-VPN
- Control
  - Out-band, out-fiber, IP-based transport for signaling
  - WRP/WDP for routing & signaling
  - OBCP for O-UNI services
  - OLMP for link management & fault isolation

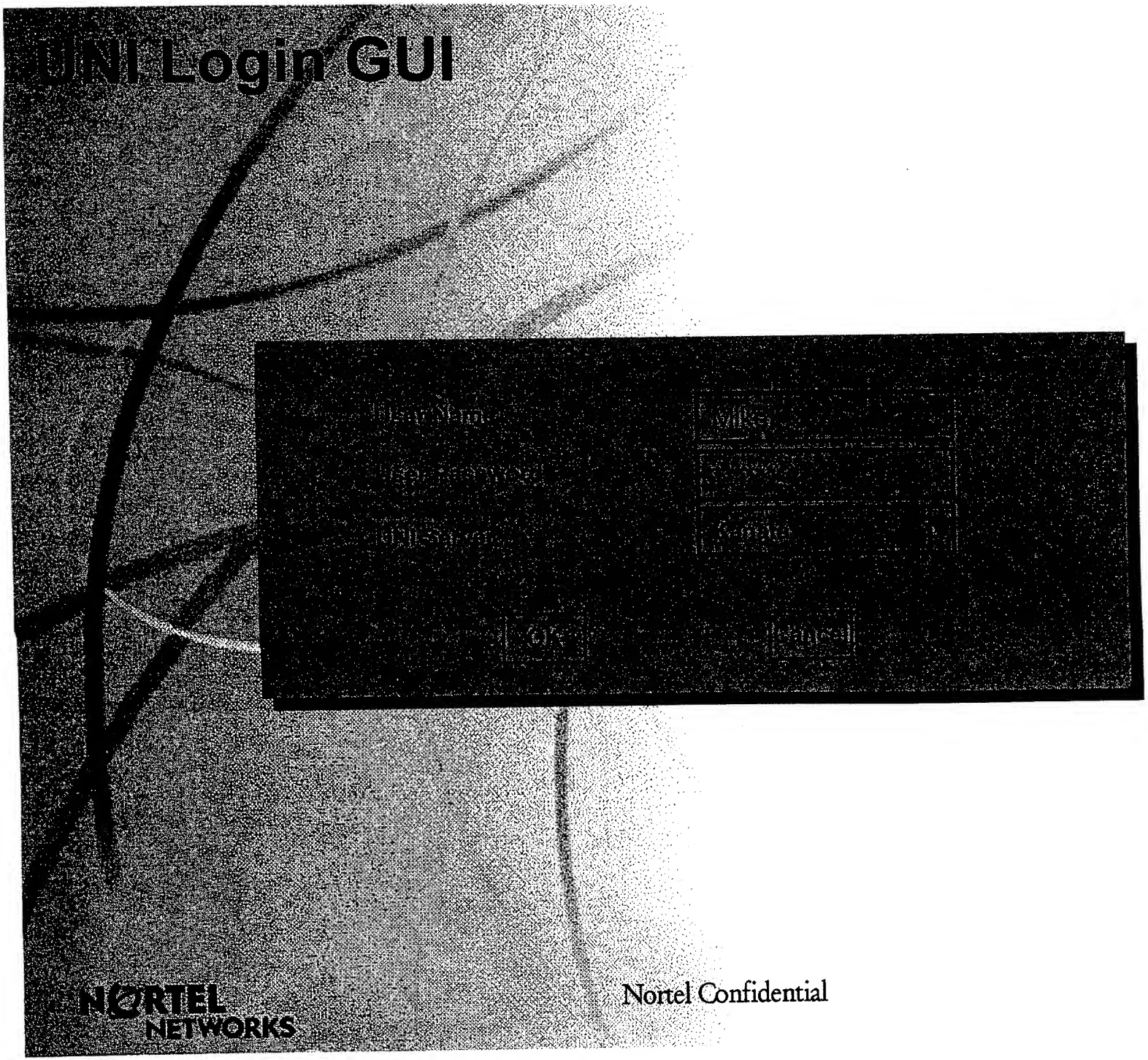
Network Configuration phase I



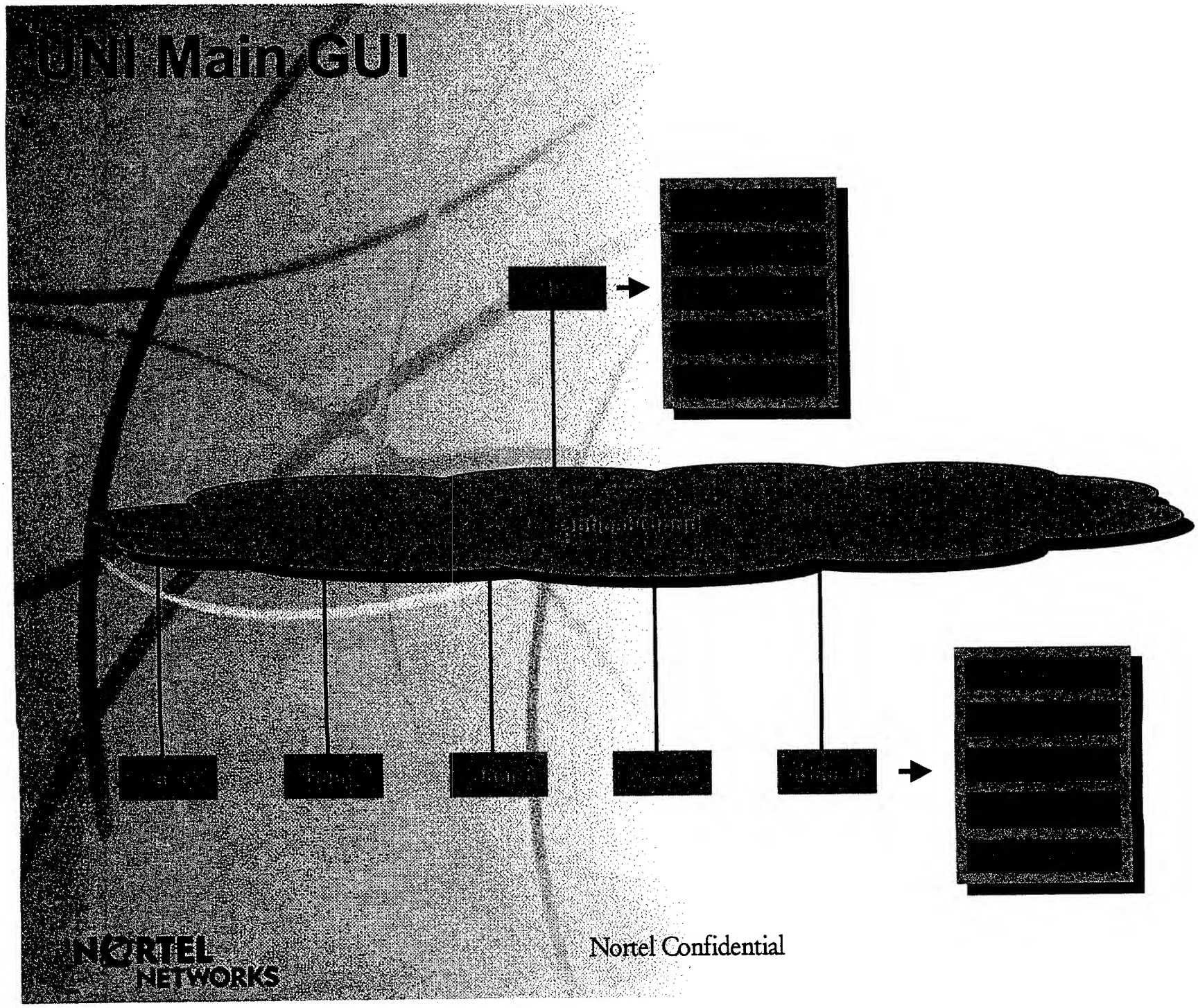
- side - single lambda
- fiber with 4 fibers per
- 8600 has true 10 GbE
- 1550 nm interface
- Bundled links

NORTEL NETWORKS

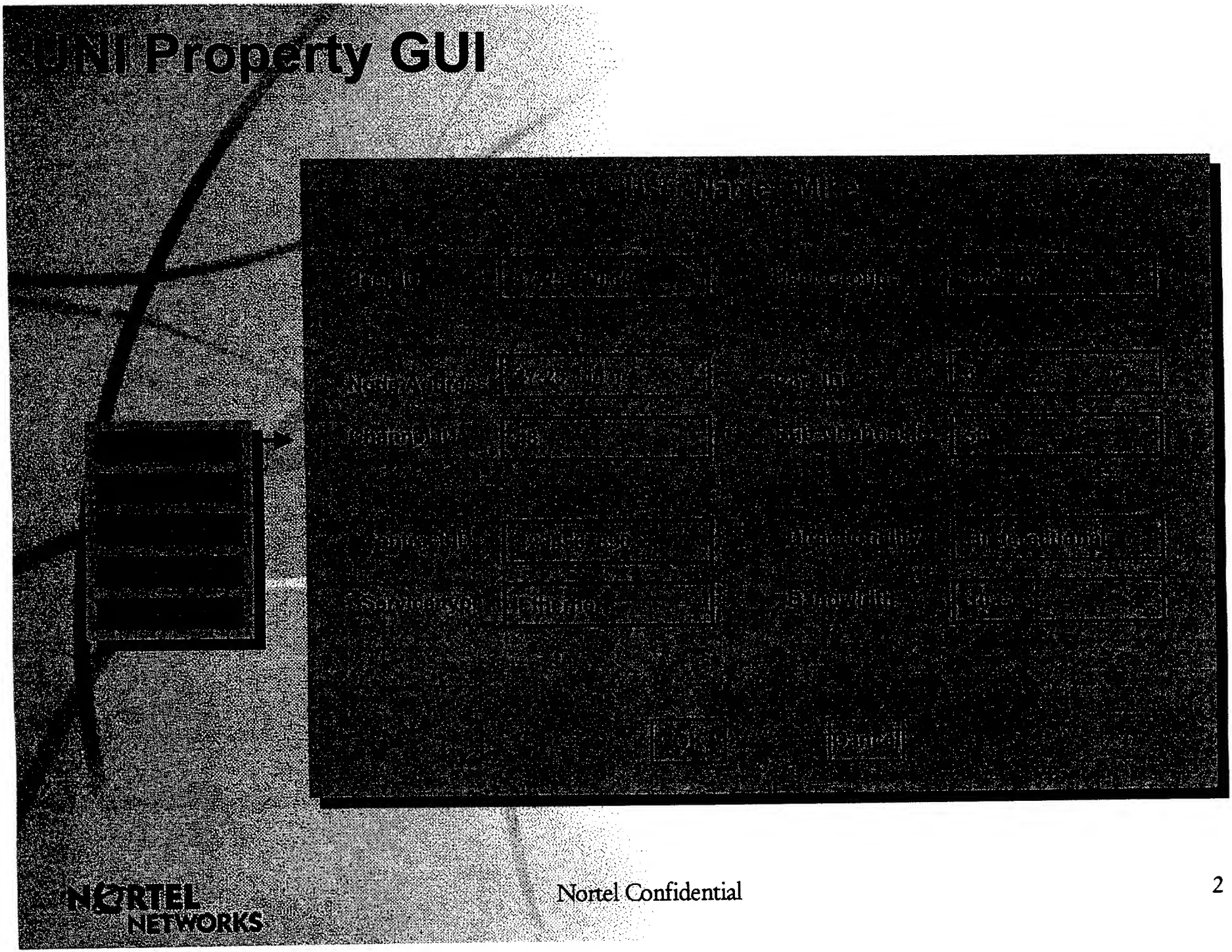
UNI Login GUI



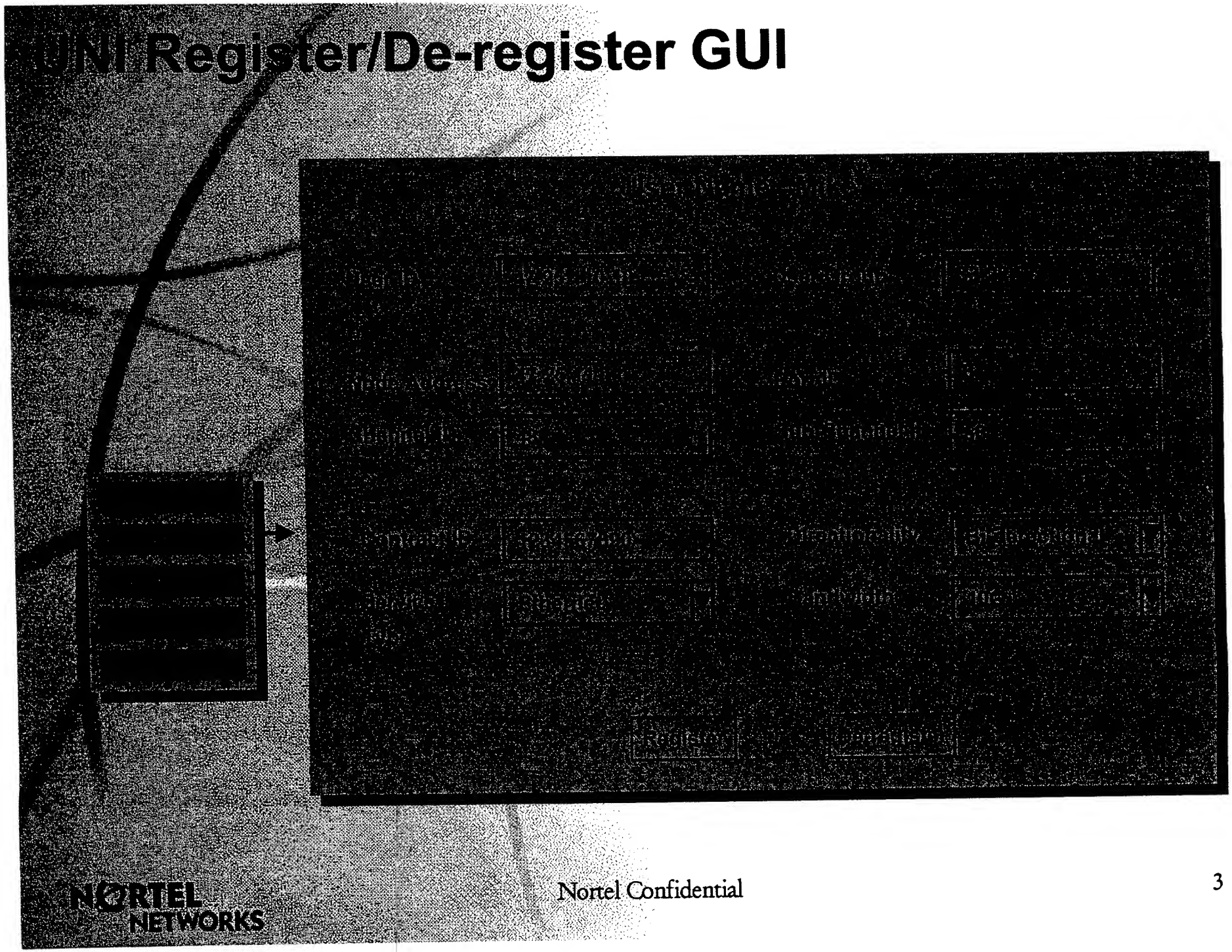
UNI Main GUI



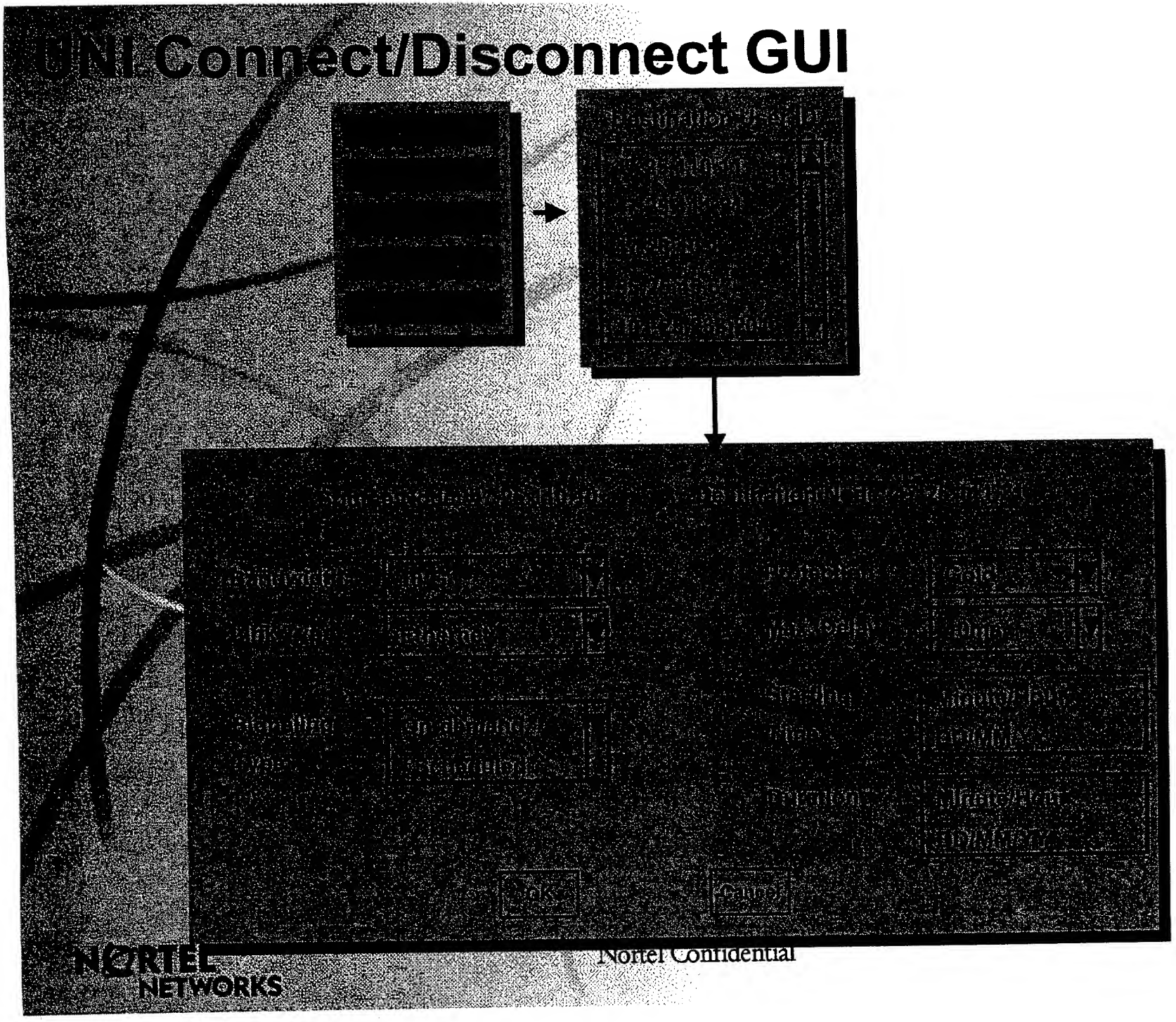
UNI Property GUI



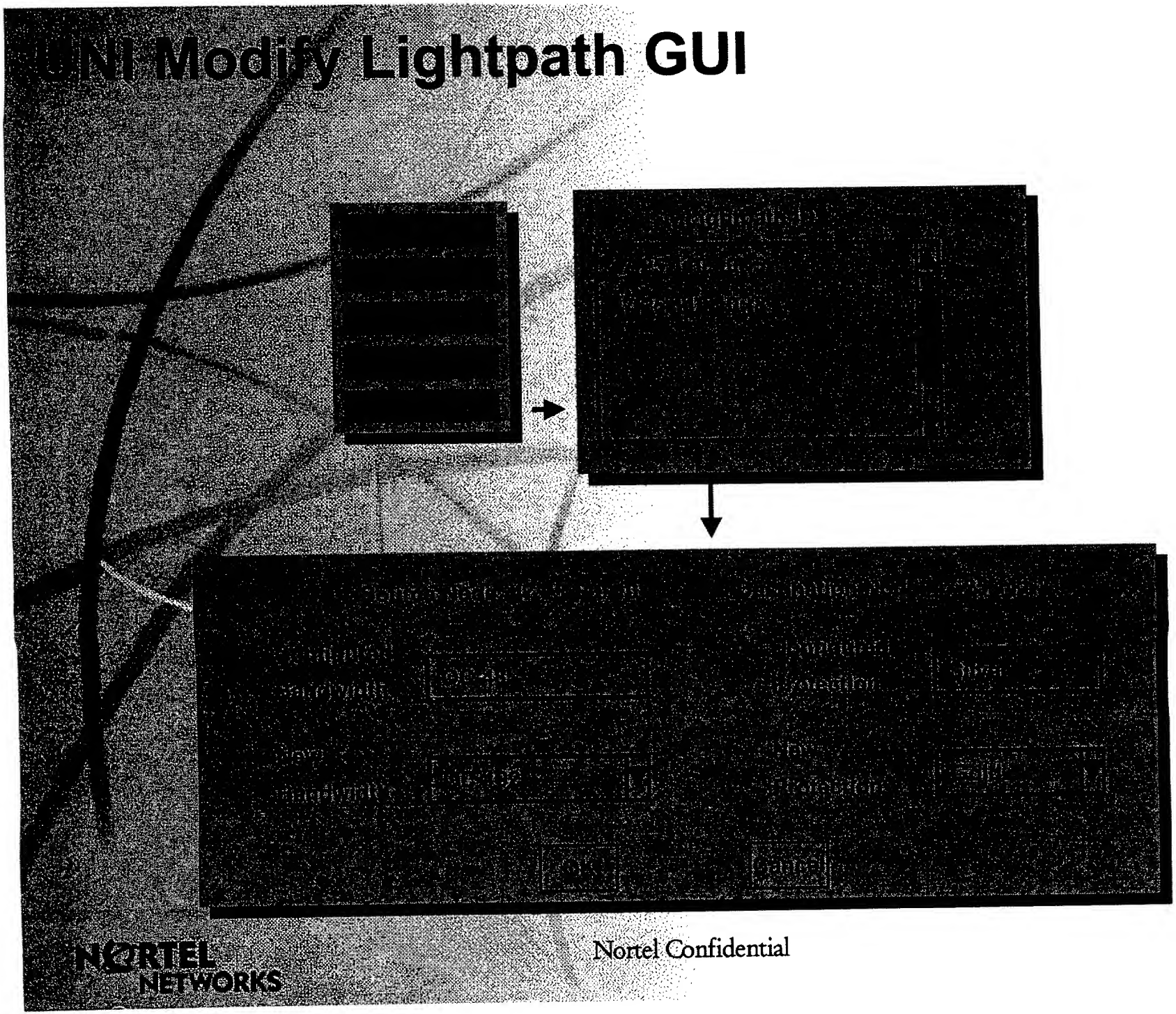
UNI Register/De-register GUI



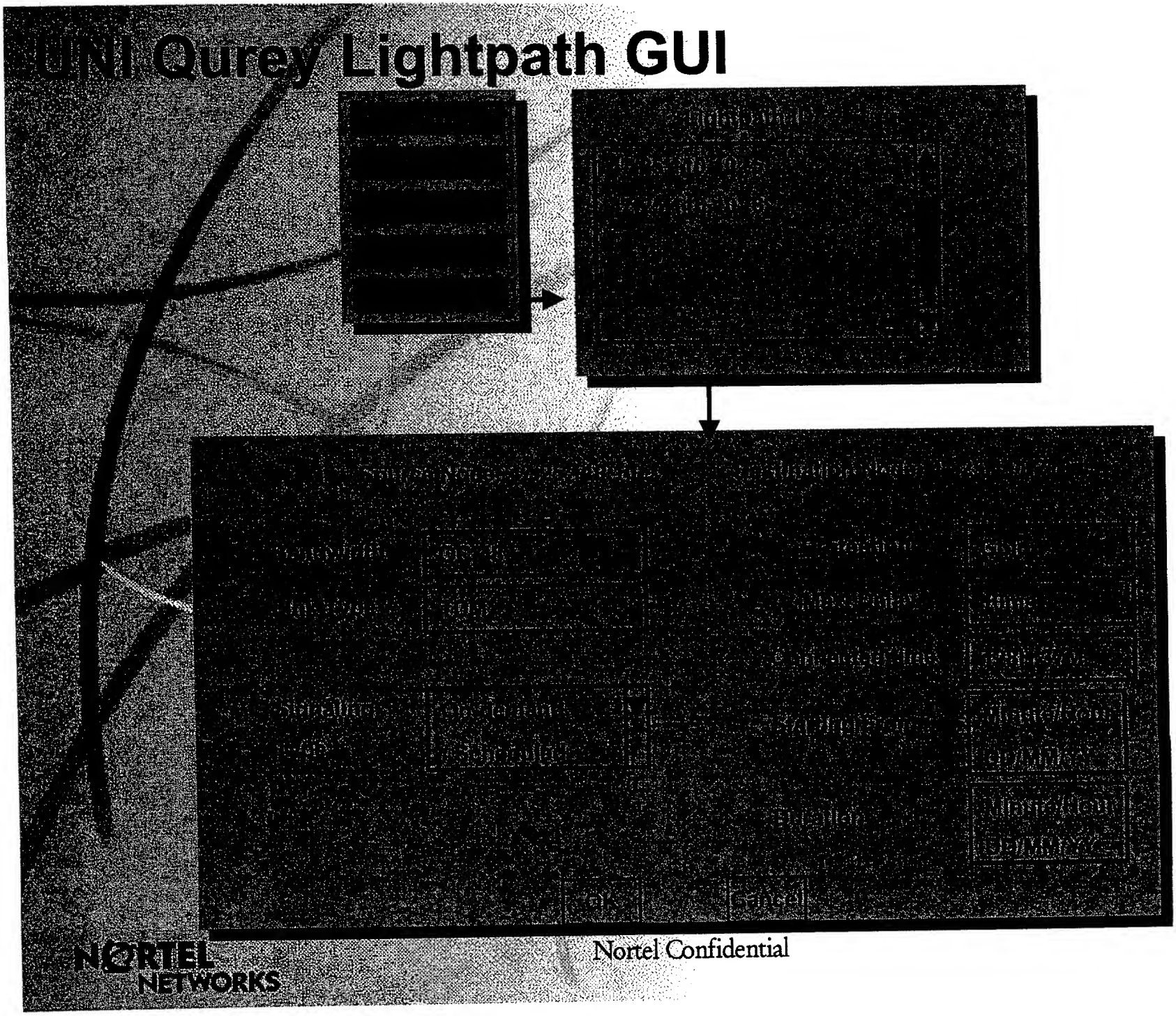
UNI Connect/Disconnect GUI

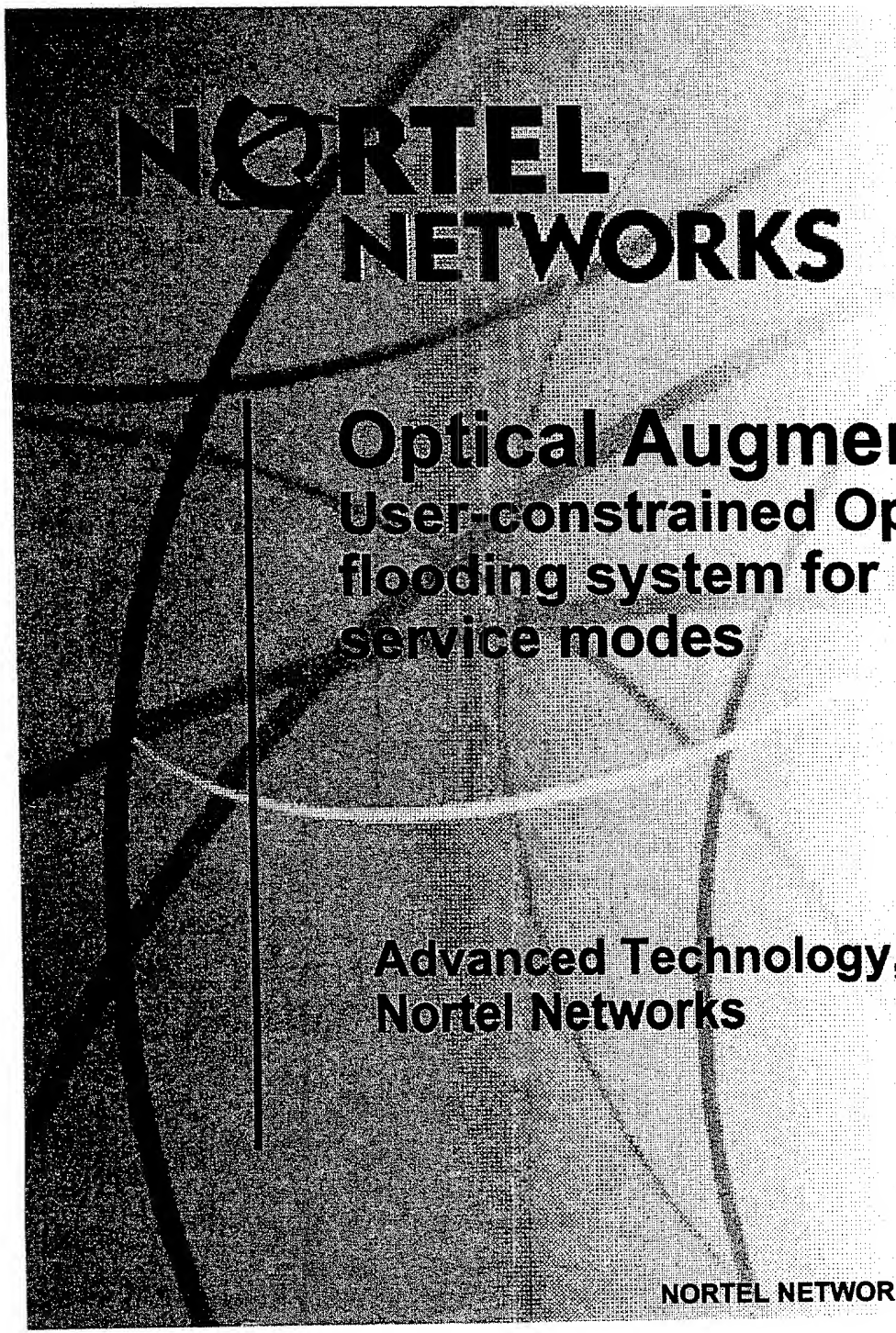


UNI Modify Lightpath GUI



UNI Qurey Lightpath GUI

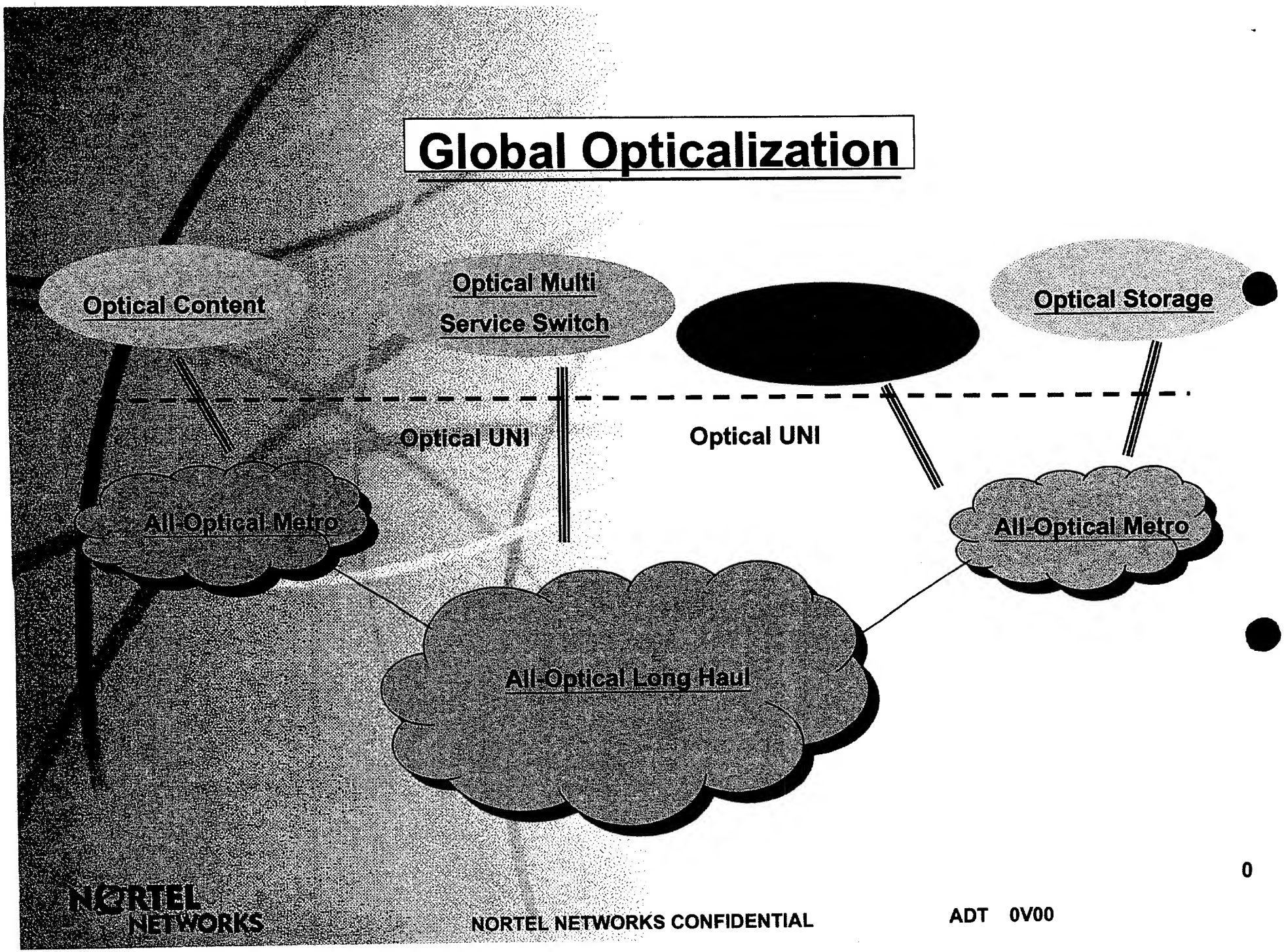




Optical Augment Routing:
User-constrained Optical route flooding system for hybrid optical service modes

Advanced Technology, 0V13
Nortel Networks

Global Opticalization



Major points of this invention

- Routing over UNI to support IP/Optical interworking
- Service link LSA for UNI
- New link semantic for constrained optical route flooding
- Hybrid optical service mode for O-VPN

Optical user, services and service modes

Optical User

- Trusted User
- UN-trusted user

Optical service

- Optical dial tone and protection
- End-system discovery
- Third party signaling
- Leased line
- Optical VPN
- Bandwidth trading

Optical service mode

- Overlay
- Peer-to-peer
- Augmented

Who manage what optical resources

Overlay model

- For UN-trusted user
- IP routing is independent from optical networks
- User signal bandwidth & protection via O-UNI signaling protocol
- Optical service providers own all optical resource (No optical routes disclosed to user)

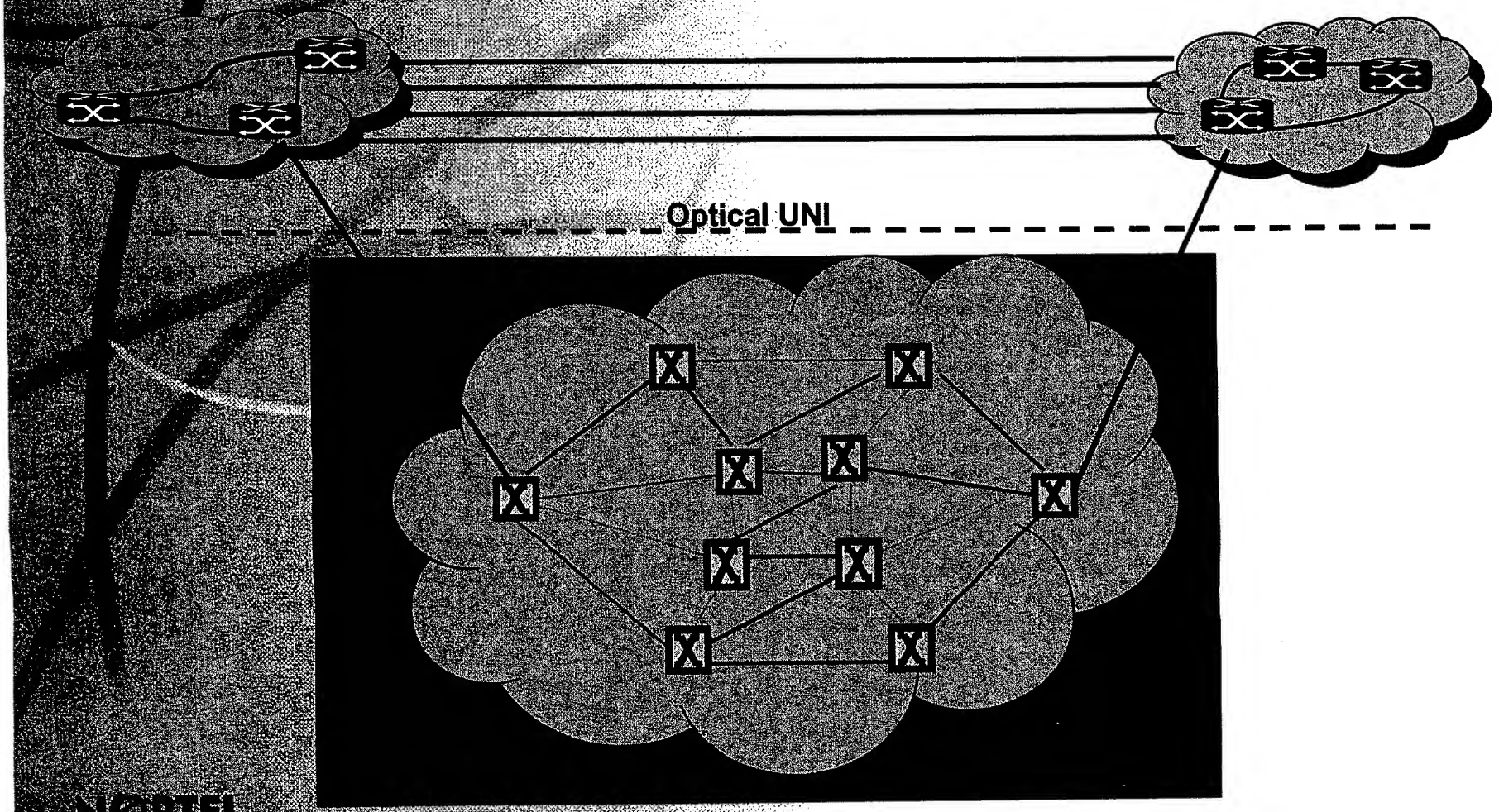
Peer-to-peer model

- For trusted user
- User signal bandwidth & protection via extended IP protocol (NNI protocol)
- User own all / partial optical resource via unified routing protocol
- Optical routes flooded into IP domain as typical IP routes (links)

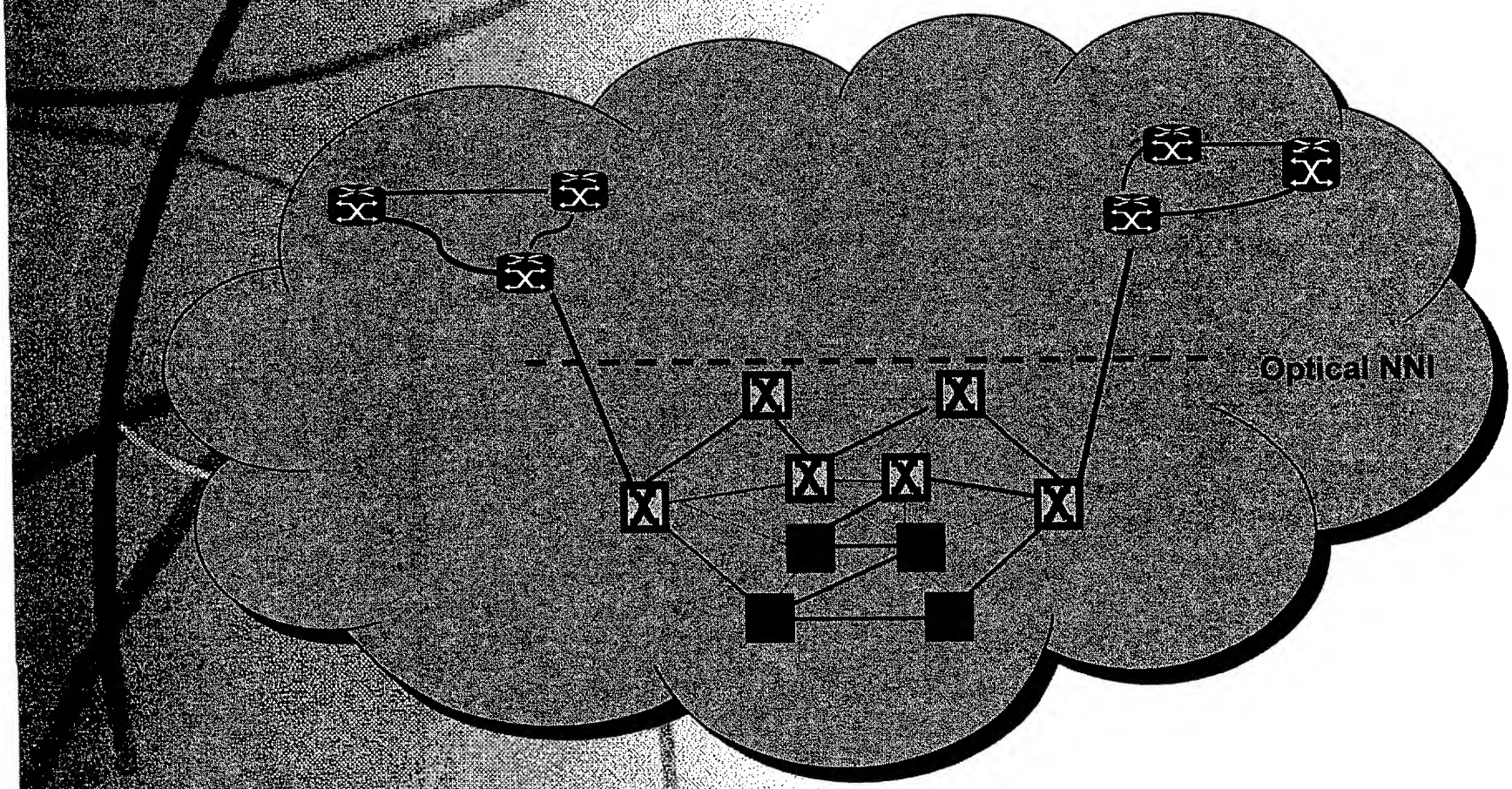
Augmented model

- For trusted user
- Separate routing protocol instances in IP and optical domain; But
- IP routing shares optical topology information at the optical edge
- Optical routes flooded into IP domain at the edge devices only.

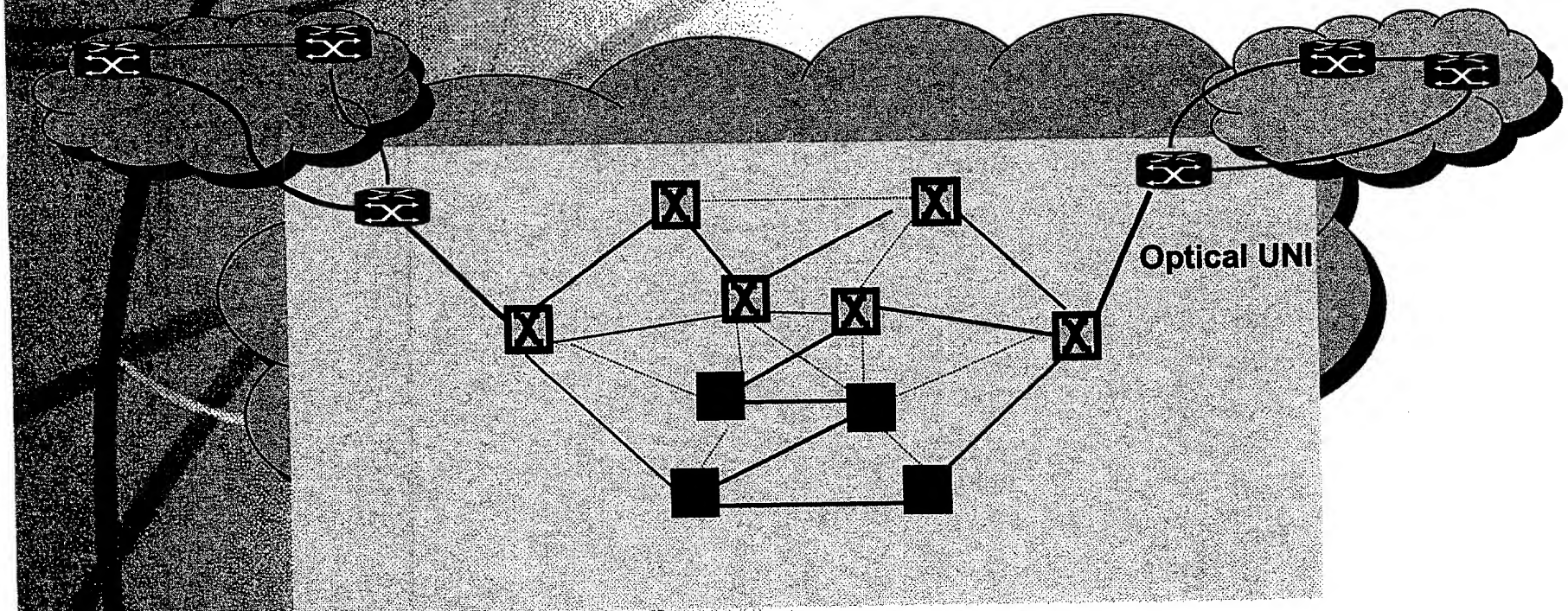
Overlay Model



Peer-to-Peer Model



Augmented Model



Why we need hybrid optical service model

- **Service flexibility**
  - Serve for trusted and UN-trusted user
  - Unify service interworking control, does not require configuration
  - UNI end-point address resolution
  - Overlay service network established transparently to optical backbone
  - Flexible service billing
- **Service domain partitioning**
  - Support O-VPN service in simple yet effective manner
  - Ease service/network management and CNM (Customer Network Management) implementation
- **Traffic engineering**
  - Bandwidth utilization
  - IP Layer protection

Domain-constrained Optical route flooding

◆Optical User Group Identification (OUGI)

- ↳O-UNI related
- ↳User Termination Point
- ↳User Group ID (e.g, VPN ID)
- ↳User Contract ID
- ↳User Service Mode (i.e, overlay, peer-to-peer, augmented)

◆Optical Link Administrative Domain

- ↳Customized-Link related (link color)
- ↳Broadcast (255.255.255.255)
- ↳Block (0.0.0.0) -- default
- ↳Specific User Group ID

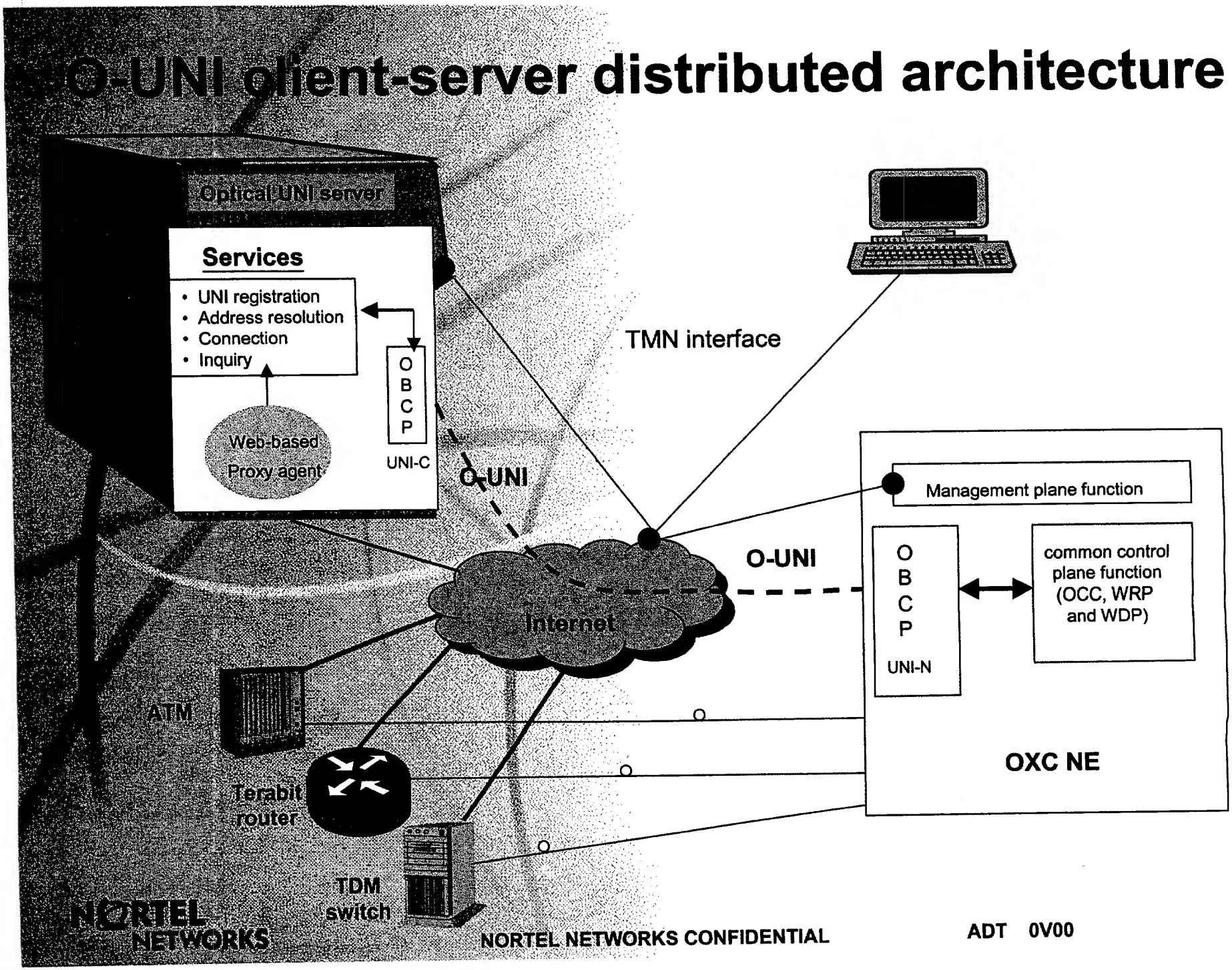
◆Optical Service LSA

- ↳Extension to Optical LSA (IETF proposal)
- ↳Optical Interface Descriptor TLV including:
- ↳User service type (e.g, ATM, IP, etc), Control protocol (BGP, PNNI, etc), Framing protocol (e.g, GE, OC-x, Fiber channel, etc), OUGI, and link color

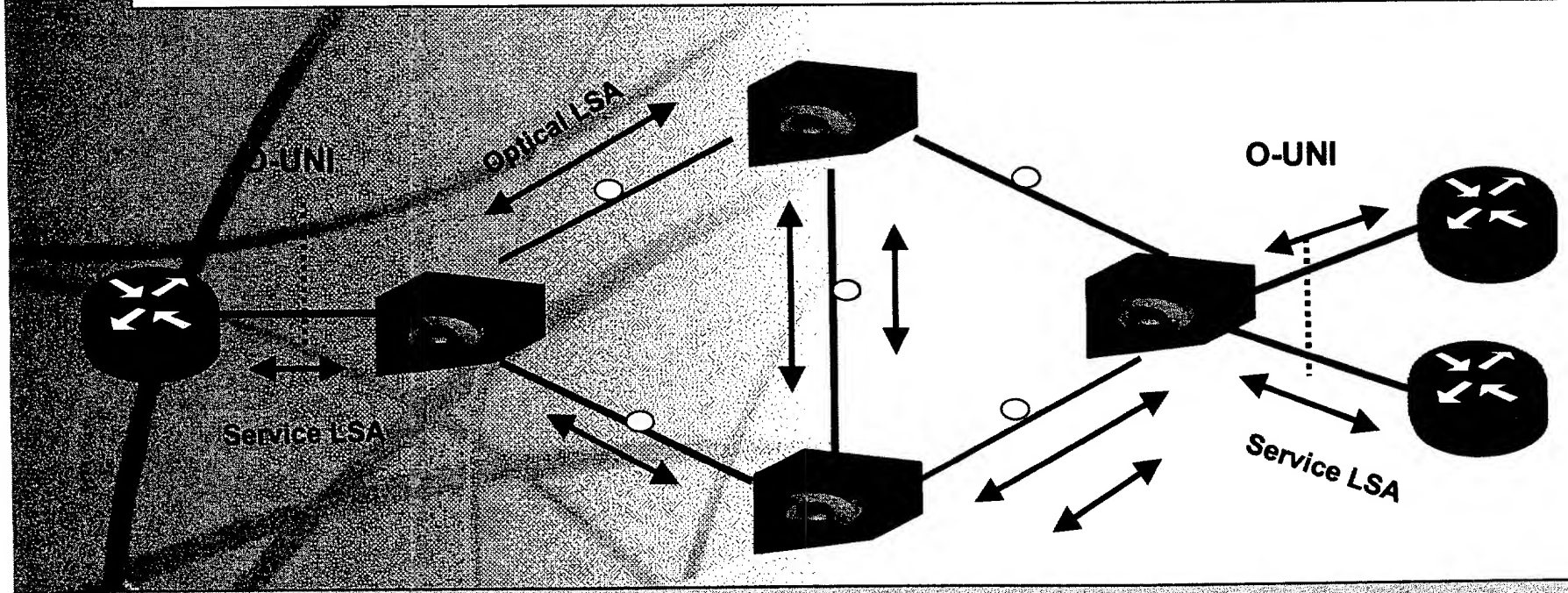
Flooding Restriction for Service Mode

Service Mode	Service LSA	Optical LSA	Other LSA
None (0)	Block	Block	Block
Overlay Mode (1)	Flooding	Block	Block
Augmented Mode (2)	Flooding	Flooding	Block
Peer-to-peer Mode (3)	Flooding	Flooding	Flooding

O-UNI client-server distributed architecture



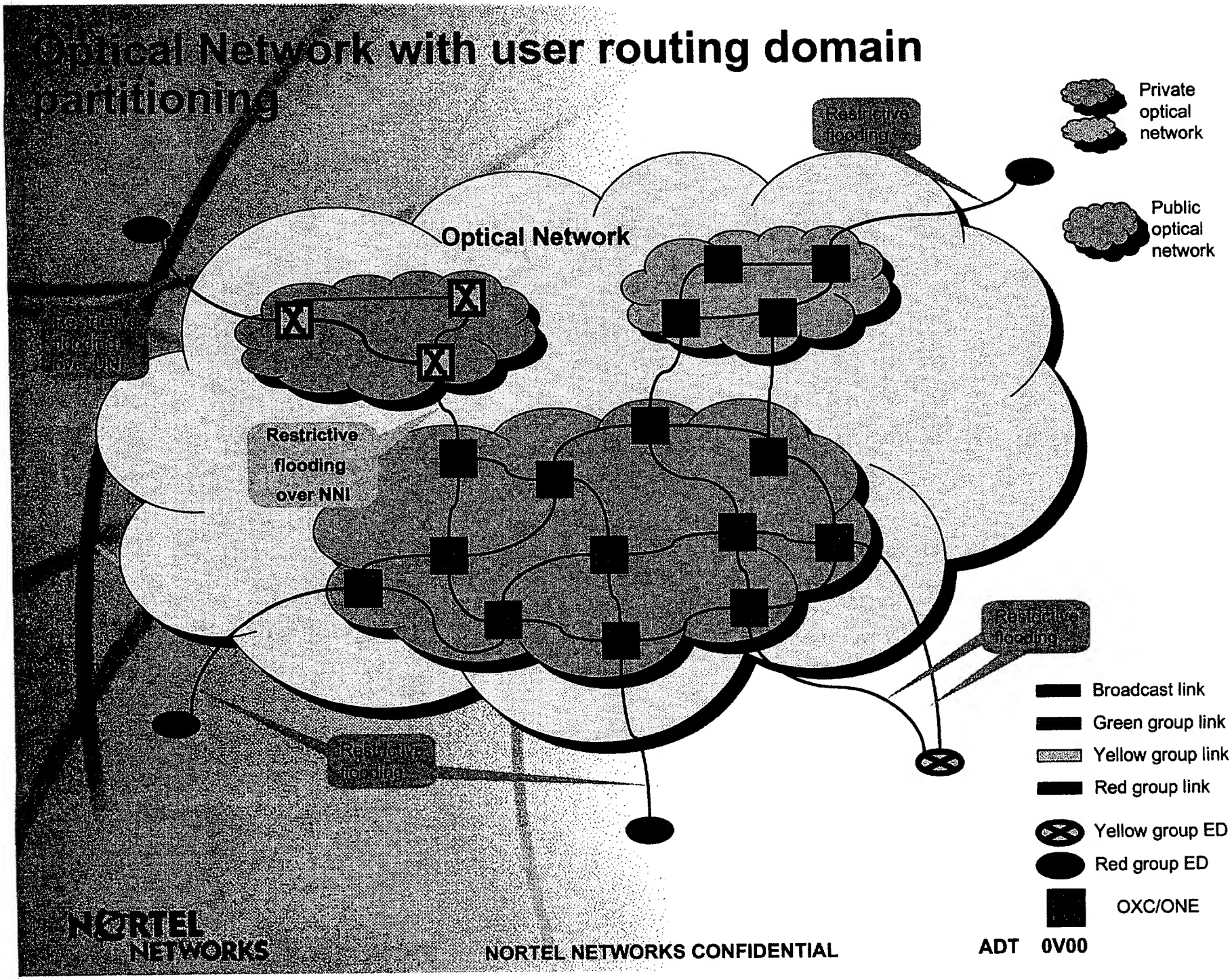
Optical LSA and Service LSA Propagation



WRP& WDP

- O-UNI / NNI is configured for each link
- WRP floods Service LSA and Optical LSA
- Optical switches check flooding domain to decide broadcast or block the propagation
- WDP issues connection request with the check of the optical UNI interface type user group ID, and available bandwidth.
- The request is confirmed or rejected.

Optical Network with user routing domain partitioning



Summery

- A hybrid optical service model is proposed
- Use flooding-constrained optical route flooding is proposed to support the hybrid service model
- Optical Interface Descriptor (OID) is defined to restrict the flooding domain
- Optical Service LSA is proposed to propagate OID
- Value-added features to IETF proposals
- Potential standard activity to IETF and OIF